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(54) Synchronous burst-access memory and word-line driving circuit therefor

Synchronisierter Burstzugriffsspeicher und Wortleitungstreiber dafür

Mémoire à accès à rafale synchronisée et circuit d'attaque de ligne de mot pour celle-ci

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EP-A- 0 135 940 **US-A- 4 513 372**

- **ELECTRONIC DESIGN. vol. 36, no. 19, 25 August 1988, HASBROUCK HEIGHTS, NEW JERSEY pages 93 - 96 SHAKAIB IQBAL 'INTERNAL TIMED RAMs BUILD FAST WRITABLE CONTROL STORES'**

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Description**BACKGROUND OF THE INVENTION**

This invention relates to a type of dynamic random-access memory (dynamic RAM, or DRAM) that is written and read in high-speed bursts synchronized with a clock signal. This novel type of memory will be referred to below as a synchronous burst-access memory.

A synchronous burst-access memory can be compared to the well-known dual-port random-access memory (dual-port RAM). A dual-port RAM basically comprises an array of DRAM memory cells and a data register. The memory cells can be accessed "at random" by latching a row address, then a column address, and reading or writing the bit or bits located at the intersection of the row and column. Alternatively, an entire row of bits can be transferred at once to the data register, then read serially in synchronization with a clock signal. Some dual-port RAMs enable data to be written serially as well as read. Serial and random access can be carried out simultaneously, and serial access can be performed at high speed.

Dual-port RAM has often been used to store image data which are read serially to generate a video signal for a raster-scan display. More recently, dual-port RAM has been used in systems employing processors of the reduced instruction-set type (so-called RISC processors), which run at high speeds and often require access to a series of bits.

A drawback of dual-port RAM is that complex on-chip circuitry is required to control two ports simultaneously. This leads to chip sizes 40% to 50% larger than general-purpose DRAM, and increases the cost of manufacturing and testing the chip.

Another drawback is that the control and address signals supplied to dual-port RAM have stringent and interrelated setup, hold, and other timing requirements, which are not easily satisfied at high operating speeds. This problem is particularly acute when the same control signals are supplied to a plurality of memory devices on a printed circuit board. Board design becomes difficult and powerful signal drivers become necessary; but these drivers generate unwanted electrical noise that can cause other devices on the board to malfunction.

Timing would be easier if all control and address signals were synchronized to a single clock signal, but existing dual-port RAM devices make no provision for this type of synchronization; the clock signal is used only to synchronize serial data output, or serial input and output. Synchronous static RAM devices are known, but their synchronization schemes are not directly applicable to dynamic RAM because row and column addresses are multiplexed in dynamic RAM, whereas they are not multiplexed in static RAM. In addition, if existing static RAM synchronization schemes were to be applied to dynamic RAM, operations such as row address decoding would not begin until after input of the synchronizing

clock edge, which would lead to delays inappropriate for a burst-access device.

US-4 513 372 discloses a memory device operating internally substantially independent of the timing of signals from its associated computer. That is, the timing controls for multiplexing the row and column address into the memory chips as well as the enabling signal for writing information into the chips are controlled by different delay lines. In addition, the input and output latches are arranged to receive or output information to or from the computer at a time that is optimal for the computer or other information requester.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to synchronize address signals, control signals, and data input and output to a single clock signal.

Another object of the invention is to reduce memory size and cost.

Yet another object of the invention is to facilitate the use of memory in multiple-processor systems.

Still another object of the invention is to facilitate the use of memory by different types of processors.

A further object of the invention is to facilitate image-processing operations.

An additional object of the invention is to enable rapid word-line driving in a synchronous memory.

These objects are achieved by a synchronous burst-access memory according to claim 1.

Further features and advantageous embodiments are stated in the dependent claims. In particular, in claim 26 a word-line driving circuit as an additional component of the memory device of the present invention is disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a first novel synchronous burst-access memory.

Fig. 2 is a timing diagram illustrating the operation of the first novel memory.

Fig. 3 is a more detailed block diagram of the first novel memory.

Fig. 4 is a block diagram of a second novel synchronous burst-access memory.

Fig. 5 is a timing diagram illustrating the operation of the second novel memory.

Fig. 6 is a block diagram of a third novel synchronous burst-access memory.

Fig. 7 is a timing diagrams illustrating the operation of the third novel memory.

Fig. 8 is a block diagram of a fourth novel synchronous burst-access memory.

Fig. 9A illustrates a block addressing scheme.

Fig. 9B is a timing diagram illustrating burst access to three blocks in Fig. 9A by the fourth novel memory.

Fig. 10 is a block diagram of a fifth novel synchro-

nous burst-access memory.

Fig. 11A illustrates two groups of three blocks each in the fifth novel memory.

Fig. 11B is a timing diagram illustrating burst access to the blocks indicated in Fig. 11A by the fifth novel memory.

Fig. 12 is a block diagram of a sixth novel synchronous burst-access memory.

Fig. 13A illustrates two four-bit blocks in the sixth novel memory.

Fig. 13B is a timing diagram illustrating burst access to the blocks indicated in Fig. 13A by the fifth novel memory.

Fig. 14 is a block diagram of a seventh novel synchronous burst-access memory.

Fig. 15 is a timing diagram illustrating the operation of the seventh novel memory.

Fig. 16 is a block diagram of an eighth novel synchronous burst-access memory.

Fig. 17 is a schematic diagram of the flag shifting circuit in Fig. 16.

Fig. 18 is a timing diagram illustrating the operation of the flag-shifting circuit.

Fig. 19 is a timing diagram illustrating the operation of the eighth novel synchronous burst-access memory when the SFT signal is high.

Fig. 20 is a timing diagram illustrating the operation of the eighth novel synchronous burst-access memory when the SFT signal is low.

Fig. 21 is a block diagram of a novel word-line driving circuit for a synchronous dynamic memory.

Fig. 22 is a timing diagram illustrating operation of the novel word-line driving circuit.

DETAILED DESCRIPTION OF THE INVENTION

Eight embodiments of the invented burst-access synchronous memory will be described with reference to Figs. 1 to 20, then a novel word-line driving device for use in synchronous dynamic RAM will be described with reference to Figs. 21 and 22. The drawings are intended to illustrate the invention but not to limit its scope.

With reference to Fig. 1, a first novel synchronous burst-access memory comprises a memory cell array 2 having memory cells disposed in intersecting rows and columns. In the drawing, rows are represented by horizontal word lines 4 and columns by vertical bit lines 6. Dynamic random-access memory cells 8 are disposed near the intersections of the bit lines and word lines, as shown in the inset in Fig. 1 for example. The memory cell array also comprises sense amplifiers and other well-known devices not explicitly shown in the drawings.

The novel memory also has a latching means 10, clocked by a clock signal CLK, for receiving and latching a row address strobe signal \overline{RAS} , a column address strobe signal \overline{CAS} , and address signals $A_0, A_1, A_2, \dots, A_k$, which are carried on an external address bus ADD. The memory must also receive one or more signals for

differentiating between read access and write access. In Fig. 1 the latching means 10 receives and latches for this purpose a write enable signal \overline{WE} and an output enable signal \overline{OE} .

5 A novel feature of the invention is that \overline{RAS} , \overline{CAS} , \overline{WE} , \overline{OE} , and the address signals A_0, \dots, A_k are all latched on rising or falling edges of the clock signal CLK. The external circuits that generate \overline{RAS} , \overline{CAS} , \overline{WE} , \overline{OE} , and the address signals accordingly need only satisfy setup and hold time requirements with respect to CLK, instead of having to meet the complex, interrelated timing requirements of conventional dynamic RAM or dual-port RAM. As a result there are comparatively liberal margins for timing skew, and timing requirements can be met by external signal-driving circuits of only moderate output, even at high clock speeds. Prior-art problems of noise on printed circuit boards can therefore be avoided.

10 The latching means 10 comprises latch circuits for latching the above-mentioned input signals, and further circuitry for passing the latched input signals to other parts of the burst-access synchronous memory, and for generating various control signals from the latched input signals. Transparent latches can be used advantageously, as will be shown later in Figs. 21 and 22.

15 The invention is not restricted to the signals shown in Fig. 1. There may be two column address strobe signals (UCAS and LCAS, for strobing an upper and lower column address), for example, or two write enable signals (\overline{UWE} and \overline{LWE}). Alternatively, \overline{WE} and \overline{OE} may be replaced by a single read/write signal (R/W). The necessary modifications will be obvious to one skilled in the art.

20 An input/output means 12, also clocked by the clock signal CLK, is connected to and controlled by the latching means 10. The input/output means has a data I/O port (marked I/O in the drawings) via which data are input to and output from the memory in serial fashion, synchronized with CLK. When not used for data input or output, the I/O port is placed in the high-impedance state.

25 The I/O port may comprise a single signal line as shown in the drawing, in which case only one data bit is input or output at a time. Alternatively, the I/O port may comprise more than one signal line, in which case two or more data bits are input or output simultaneously. The number of bit lines (actually bit line pairs) per column in the memory cell array equals the number of data lines in the I/O port.

30 A row address decoding means 14 connected to the memory cell array 2 and the latching means 10 receives the latched address signals A_0, \dots, A_k and a first internal control signal from the latching means 10, decodes the address information, thereby selects one of the word lines 4, and drives this word line, thus selecting a row of memory cells in the memory cell array 2. The first internal control signal, which controls the time at which these operations are carried out, is generated from the row

address strobe signal \overline{RAS} and the clock signal CLK. Alternatively, \overline{RAS} and CLK may be passed directly to the address decoding means 14 as the first internal control signal.

An address counting means 18 is connected to and controlled by the latching means 10 and receives the clock signal CLK. By counting CLK pulses, the address counting means 18 generates a consecutive series of column addresses (A) starting from a preset address as will be described later. Each address A comprises m address bits $A_0, A_1, A_2, \dots, A_m$. The address counting means 18 thus operates as a presetable ($m + 1$)-bit counter. The number of address bits A_0, \dots, A_m generated is equal to or greater than the number of address bits A_0, \dots, A_k latched by the latching means 10.

A column address decoding means 20 connected to the address counting means 18 decodes the column addresses output by the address counting means 18 and selects corresponding columns in the memory cell array 2, selecting one column at a time.

A data transfer means 22, connected to the memory cell array 2, the input/output means 12, and the column address decoding means 20, transfers data from the memory cell array 2 to the input/output means 12, and from the input/output means 12 to the memory cell array 2. The data are transferred to and from only those memory cells 8 disposed in the column selected by the column address decoding means 20, in the row selected by the row address decoding means 14. Data are thus transferred to or from a consecutive series of column positions in the row, one column position at a time.

The operation of this memory will be explained with reference to Fig. 2, which illustrates a burst read access.

To read data from the novel memory, an external device such as a processor begins by driving \overline{RAS} low (active) and sending a row address X_a on the address bus ADD. At time t_0 the latching means 10 latches \overline{RAS} and the row address X_a . The row address decoding means 14 decodes X_a and selects one of the word lines 4 in the memory cell array 2.

This and other latching operations are shown synchronized to rising edges of the clock signal CLK, but the invention is of course not restricted to the rising edge; synchronization may be with the falling edge instead, or with both edges.

Next the processor drives \overline{CAS} and \overline{OE} low (active) and sends a column address Y_a on the address bus ADD. At time t_1 the latching means 10 latches \overline{CAS} and \overline{OE} and sets the value of Y_a in the address counting means 18. The column address Y_a may be latched in the latching means 10, using a latch separate from the latch that holds the row address X_a . Alternatively, the column address Y_a may be passed directly through the latching means 10 to the address counting means 18. In either case, the column address Y_a is passed to the address counting means 18 together with a second internal control signal commanding the address counting means 18 to preset to the value Y_a . The second internal

control signal can be generated from \overline{CAS} and CLK: for example, from the first rising edge of CLK after \overline{CAS} goes low.

If the number of address bits A_0, \dots, A_m output from the address counting means 18 exceeds the number of address bits A_0, \dots, A_k received by the latching means 10, the column address Y_a is set in the $k + 1$ most significant bits of the $m + 1$ bits of the address counting means 18, and the other bits are cleared to zero. From \overline{CAS} and \overline{OE} the latching means 10 also generates and sends to the input/output means 12 a signal commanding the input/output means 12 to commence output operations.

The column address decoding means 20 decodes the column address A_0, \dots, A_m output by the address counting means 18, thereby selecting one column in the memory cell array. The data transfer means 22 transfers the data D_1 in the memory cell or cells at the intersection of this column and the row selected by the row address decoding means 14 to the input/output means 12 for output at the I/O port. The processor can latch the data D_1 at time t_2 .

The address counting means 18 now increments by one, selecting the next column, and the data D_2 in this column in the selected row are output in the same way at time t_3 . Operation continues in this way at times t_4, t_5, \dots, t_n . At each CLK cycle the address counting means 18 increments by one and a new column of data in the same row is output.

After receiving data $n - 1$ times, the processor drives \overline{CAS} high (inactive) again. At time t_{n+1} the latching means 10 latches the inactive \overline{CAS} signal and sends the input/output means 12 an internal control signal commanding it discontinue output operations. When the last data D_n has been output, the input/output means 12 places the I/O port in the high-impedance state, denoted HZ in the drawings. The processor then drives \overline{RAS} and \overline{OE} high (inactive) to end the burst access.

To write data to the novel memory, the processor follows a similar procedure except that it leaves \overline{OE} high and drives \overline{WE} low, causing the input/output means 12 to perform input instead of output. Data provided by the processor in synchronization with the clock signal CLK are transferred from the I/O port via the data transfer means 22 to successive columns of memory cells in the selected row in the memory cell array 2.

If the I/O port consists of a single signal line, then each of the data D_1, \dots, D_n consists of a single bit. If the I/O port consists of multiple signal lines, then each of the data D_1, \dots, D_n consists of multiple bits.

In its simplest and generally preferable form the data transfer means 22 comprises only gating means for connecting bit lines 6 in the selected column to the input/output means 12. If necessary, however, the data transfer means 22 may have a data register as in conventional dual-port RAM. In this case an entire row of data is transferred from the selected word line to the data transfer means 22 at the beginning of the burst access,

between times t_0 and t_1 in Fig. 2, and stored in the data register. The data in the data register are then written or read at times t_1 to t_{n+1} . For write access, after time t_{n+1} the entire row of data is transferred back from the data transfer means 22 to the selected row in the memory cell array 2.

Since address signals (A_0, \dots, A_k) and control signals ($\overline{RAS}, \overline{CAS}, \overline{WE}, \overline{OE}$) are sent to the memory only once per burst, access takes place much more rapidly than with conventional dynamic RAM, new data being obtained in every clock cycle. Since the novel memory has only one port, it is smaller, simpler, and less expensive to manufacture and test than conventional dual-port RAM. It is also simpler to control.

Unlike conventional dual-port RAM, the novel memory does not enable random and serial access to be performed simultaneously. Many personal computer systems and other systems that employ dual-port RAM do not need to access the two ports simultaneously, however. Such systems will obtain significant cost benefits from using the novel memory.

Fig. 3 is a somewhat more detailed block diagram of the first novel memory. Fig. 3 is shown mainly to relate the foregoing description to the descriptions of subsequent novel memories, in which further elements will be added.

In Fig. 3 the latching means 10 is shown to comprise an input latch circuit 30 for latching \overline{RAS} , \overline{CAS} , \overline{WE} , and \overline{OE} , and an address buffer 31 connected to the external address bus ADD for latching address signals. A memory control signal generating circuit 32 connected to the output side of the input latch circuit 30 generates internal control signals, and controls the address buffer 31 so that row addresses are sent to the row address decoding means 14 and column addresses to the address counting means 18. Control signals from the memory control signal generating circuit 32 are conveyed to the address buffer 31, the address counting means 22, and the input/output means 12 via several signal lines which are shown for convenience in the drawings as a single signal line 33.

The output side of the address buffer 31 is connected via an internal column address bus 34 to the address counting means 18, and via an internal row address bus 35 to the row address decoding means 14. The row address decoding means 14 comprises a row address decoder 41 and a word-line driver 42. The row address decoder 41 decodes the row address received from the address buffer and selects one of the word lines, such as WL_i in the drawing. The word-line driver 42 drives the selected word line WL_i .

The input/output means 12 comprises an input/output control circuit 36 and an input/output circuit 53, both of which receive the clock signal CLK. The input/output circuit 53 is connected to the data transfer means 22 via an internal data bus 52 comprising one or more data lines, which are connected via well-known buffer circuits not explicitly shown in the input/output circuit 53 to the

equal number of data lines in the I/O port. The input/output control circuit 36 receives control signals from the memory control signal generating circuit 32 via the signal line 33, and sends further control signals to the input/output circuit 53 via a signal line 54. These further control signals place the input/output circuit 53 in the input state, the output state, or a high-impedance state in which neither input nor output is performed.

Fig. 4 is a block diagram of a second novel synchronous burst-access memory. Elements identical to elements in Fig. 3 are identified by the same reference numerals.

The second novel memory differs from the first novel memory in having a frequency divider 57 that receives the clock signal CLK, divides its frequency by a factor N (where N is a positive integer), thus generates an internal clock signal CLKa, and supplies CLKa in place of CLK to the input latch circuit 30, the address buffer 31, the address counting means 18, the input/output control circuit 36, and the input/output circuit 53. Frequency dividing circuits are well known, so a detailed description will be omitted. The frequency division ratio N can be selected by one or more external control signals not shown in the drawing. Alternatively, N can be permanently selected when the memory is fabricated, by a manufacturing option such as a metalization mask option, laser trimming option, or wire bonding option.

Fig. 5 illustrates burst access for the case of N = 2. For convenience the external clock signal CLK is shown as having twice the frequency of the CLKa signal in Fig. 2. The CLKa signal obtained by dividing the frequency of CLK by two accordingly has the same frequency in Fig. 5 as CLK in Fig. 2. The burst access shown in Fig. 5 is identical to that in Fig. 2 except that CLK is replaced by CLKa.

While some processors are capable of completing one memory access in every clock cycle, others require two or more clock cycles per access. The frequency divider 57 enables the novel memory in Fig. 4 to be easily adapted for use with processors having different access speeds. Users will benefit by not having to provide a separate clock-dividing circuit. Manufacturers will benefit by being able to offer a single memory device suitable for a wide range of applications.

If the frequency division ratio N is controllable by external signal input, the second novel memory can be used in a system having two or more processors that access memory at different speeds. When accessing the memory, each processor selects the appropriate value of N by driving the external control signal or signals to the appropriate levels.

Fig. 6 is a block diagram of a third novel synchronous burst-access memory. Elements identical to elements in Fig. 3 are identified by the same reference numerals.

The third novel memory has, in addition to the circuit elements shown in Fig. 3, a clock control circuit 58 for blocking input of the clock signal CLK to the address

counting means 18 and the input/output means while $\overline{\text{CAS}}$ is high. The clock control circuit comprises, for example, a two-input OR gate 59: one input receives CLK; the other receives $\overline{\text{CAS}}$ from the memory control signal generating circuit 32. The output CLKb of the OR gate 59 is thus high whenever $\overline{\text{CAS}}$ is high, and is identical to CLK when $\overline{\text{CAS}}$ is low. CLKb is supplied to the address counting means 18, the input/output control circuit 36, and the input/output circuit 53 in place of CLK.

Fig. 7 illustrates a burst read access for the third novel memory. $\overline{\text{CAS}}$ is initially held low for substantially three CLK cycles, causing the clock control circuit 58 to generate three CLKb pulses. Data D_1 , D_2 , and D_3 are output and the address counting means 18 increments three times. Next $\overline{\text{CAS}}$ is held high for substantially four CLK cycles, causing CLKb to remain high for a similar interval. During this interval the address counting means 18 does not increment, and a third internal control signal generated by the memory control signal generating circuit 32 causes the input/output control circuit 36 to place the input/output circuit 53 in the high-impedance state. $\overline{\text{RAS}}$ remains low; the same word line remains selected in the memory cell array 2. Next $\overline{\text{CAS}}$ is driven low for three CLK cycles again, causing three more CLKb pulses to be produced, the address counting means 18 to increment three times, and the data D_4 , D_5 , and D_6 to be output. Finally, both $\overline{\text{CAS}}$ and $\overline{\text{RAS}}$ are driven high, ending the burst access.

Write access is similar to read access except that WE is driven low instead of OE.

The third novel memory is particularly useful in systems in which the same data bus is shared by two or more processors or other bus-master devices. While a first processor is engaged in a long burst access, a second processor may obtain use of the bus by asking the first processor to release the bus temporarily. The first processor does so by driving $\overline{\text{CAS}}$ high. When the second processor has finished using the bus, the first processor continues its access by driving $\overline{\text{CAS}}$ low again without having to generate new address information.

Fig. 8 is a block diagram of a fourth novel synchronous burst-access memory. Elements identical to elements in Fig. 3 are identified by the same reference numerals.

The fourth novel memory has an access counting means 60 for counting clock signals and halting input or output when a predetermined number of accesses have been performed. In Fig. 8 the access counting means 60 comprises a down-counter 61 connected to the address buffer 31 via an internal address bus 62, to the memory control signal generating means 32 via the signal line 33, and to the address counting means 18 and the input/output control circuit 36 via a signal line 64. The down-counter 61 preferably has the same bit width as the address counting means 18.

In this fourth novel memory the bit width of the external address bus ADD differs from the bit width of the address counting means 18 and the down-counter 61.

As an example, it will be assumed that $m = k + 2$.

When $\overline{\text{CAS}}$ becomes active for the first time after $\overline{\text{RAS}}$ becomes active, the value A_0, \dots, A_k input to the address buffer 31 on the next rising edge of CLK presets the most significant bits of the address counting means 18, the two remaining bits A_{k+1} and A_{k+2} of the address counting means 18 being cleared to zero as mentioned earlier. After this, while $\overline{\text{RAS}}$ remains active, if $\overline{\text{CAS}}$ becomes inactive, then active for a second time, the value A_0, \dots, A_k input to the address buffer 31 on the next rising edge of CLK presets the $k + 1$ most significant bits of the down-counter 61, without affecting the remaining bits of the down-counter 61. These presetting operations are controlled by internal control signals provided by the memory control signal generating means 32.

Fig. 9A shows the address structure of the memory cell array 2 in the fourth novel memory. For simplicity it will be assumed that the I/O port and the internal data bus 51 consist of only a single data line each, so that the memory cell array 2 has one bit per column. This is not a restriction on the invention; the structure can easily be extended to multiple bits per column.

A given row address X input to the memory designates a single word line, but a $(k + 1)$ -bit column address Y designates four bits (four columns) in that word line, such a group of four bits being referred to herein as a block. The four bits in the block corresponding to row address X_1 , column address Y_1 are identified by circles with different quadrant markings, and bits in the two succeeding blocks are similarly identified. Burst access to these twelve bits will be illustrated next.

Fig. 9B illustrates a burst read access for the fourth novel memory. The row address X_1 is latched at time t_1 and the column address Y_1 at time t_2 . The address counting means 18 is preset with Y_1 in the most significant $k + 1$ bits and zero in the two remaining bits. At the same time the down-counter 61 is cleared to zero.

The address counting means 18 now begins incrementing, generating column addresses that select individual bits in the memory cell array. In the first four clock cycles after t_2 the four bits in block (X_1, Y_1) are selected for access, one after another; in the next four clock cycles the four bits in the block $(X_1, Y_1 + 1)$ are selected and accessed; then the four bits in the block $(X_1, Y_1 + 2)$ are selected and accessed.

In the meantime, in the next clock cycle after t_2 the processor drives $\overline{\text{CAS}}$ high; then it drives $\overline{\text{CAS}}$ low again and places an access count on the external address bus ADD, indicating the number of blocks to be accessed. In this example the access count is $N = 3$. This value is transferred from the address buffer 31 to the most significant $k + 1$ bits of the down-counter 61 at time t_3 .

At the moment when this value is transferred from the address buffer 31 to the down-counter 61, the down-counter 61 has already decremented from zero to, for example, minus two: in binary notation, from $(00\dots 00000)_B$ to $(11\dots 11110)_B$. The value $(10)_B$ in the two least significant bits is left unaltered and the value three, or

$(00\dots011)_B$, is set in the other bits, so the complete value of the down-counter 61 becomes, for example, $(00\dots01110)_B$ or fourteen.

The down-counter 61 is designed to generate a count-out signal when its count reaches a certain value: for example, the value three, or $(00\dots00011)_B$, at which the most significant $k+1$ bits all become zero. This value should be selected so that it is reached when the requested number of blocks have been accessed. The count-out signal (referred to elsewhere as a fourth internal control signal) is sent via the signal line 64 to the address counting means 18 and the input/output control circuit 36 in Fig. 8, causing the address counting means 18 to stop counting and the input/output control circuit 36 to place the I/O port in the high-impedance state. After this, the processor drives \overline{CAS} and other control signals inactive.

Write access is similar to read access except that \overline{WE} is driven low instead of \overline{OE} .

The fourth novel memory has the same advantages as the first novel memory, with the following additional advantages.

In read access, the I/O port is placed in the high-impedance state as soon as the necessary number of bits have been accessed, even if the processor does not immediately deactivate \overline{CAS} and other control signals. This feature is useful in a system having a shared data bus, since it enables the data bus to be transferred promptly to another device.

In write access, image-processing operations such as clip and fill can be carried out extremely conveniently. The access count can be used to control the number of bits written, thereby masking bits which are to be left unaltered.

In both read access and write access, the processor can control the number of bits accessed without having to deactivate \overline{CAS} and other control signals at exact times.

The block address structure shown in Fig. 9A enables memory capacity to be increased without increasing either the number of external address lines (A_0, \dots, A_k) or the number of data lines in the I/O port, and furthermore enables access to begin even before the access count is received. Similar block structures can be employed in the first, second, and third novel memories.

The fourth novel memory can easily be adapted to block structures in which all bits in the same block are disposed in the same column and have the same column address A_0, \dots, A_m , but are accessed in a serial manner by the input/output means. In this case k and m may be equal, the address counting means 18 being, for example, an $(m+3)$ -bit counter that outputs only the $m+1$ most significant bits A_0, \dots, A_m , so that the column address changes only once every four clock cycles.

The inventive concept of the fourth novel memory is also applicable to memories having a non-blocked address structure. In this case the start of data input or output may be delayed until the access count has been

preset in the down-counter 61.

Fig. 10 is a block diagram of a fifth novel synchronous burst-access memory. Elements identical to elements in Fig. 8 are identified by the same reference numerals.

The fifth novel memory also has an access counting means 60 for counting accesses and halting input or output when a requested number of accesses have been performed. The difference from the fourth novel memory is that the access counting means 60 comprises a register 65, an up-counter 66, and a match detecting circuit 67, instead of the down-counter 63 in the fourth novel memory. The register 65 and up-counter 66 have the same bit width as the address counting means 18.

The register 65 is connected via the internal address bus 62 to the address buffer 31. As in the fourth novel memory, after \overline{RAS} goes low, when \overline{CAS} goes low for the first time, the memory control signal generating circuit 32 commands the address buffer 31 to send the current address value to the address counting means 18. When \overline{CAS} goes low for the second time, the memory control signal generating circuit 32 commands the address buffer 31 to send the current address value to the register 65. In the case of a block-structured memory, the address values set the most significant $k+1$ bits of the address counting means 18 and the register 65. The register 65 stores the value received from the address buffer 31 until it receives a new value from the address buffer 31, and outputs the stored value to the match detecting circuit 67.

The up-counter 66 counts CLK cycles and outputs the count to the match detecting circuit 67. The up-counter 67 is reset to an initial value such as zero by a control signal generated by the memory control signal generating circuit 32 when \overline{CAS} goes low for the first time after \overline{RAS} goes low.

The match detecting circuit 67 is connected to the address counting means 18 and the input/output control circuit 36 via the signal line 64. The match detecting circuit 67 compares the count output by the up-counter 66 with the value received from the register 65. When this count and value match, the match detecting circuit 67 generates an internal control signal on the signal line 64. This internal control signal (also referred to as a fourth internal control signal) causes the address counting means 18 to stop counting, and the input/output control circuit 36 to place the input/output circuit 53 in the high-impedance state.

The operation of the fifth novel memory will be explained with reference to Figs. 11A and 11B, which show two twelve-bit burst accesses.

As illustrated in Fig. 11A, the first twelve bits to be accessed are located in three consecutive blocks starting at row address X_1 , column address Y_1 . The second twelve bits are located in three consecutive blocks starting at row address X_2 , column address Y_2 .

With reference to Fig. 11B, the processor first drives \overline{RAS} low and sends the row address X_1 , then drives

$\overline{\text{CAS}}$ low and sends the column address Y_1 . At time t_2 the column address Y_1 is passed from the address buffer 31 to the address counting means 18. At the same time, the up-counter 66 is cleared to zero. Output of data now begins as in Fig. 9B, with the up-counter 66 counting the number of bits output.

Next the processor drives $\overline{\text{CAS}}$ high for one CLK cycle, then drives $\overline{\text{CAS}}$ low again and sends the access block count ($N = 3$). At time t_3 this count is sent from the address buffer 31 to the register 65 and stored in the most significant bits of the register 65. In this memory the bit width of the address counting means 18, the up-counter 66, and the register 65 is two greater than the bit width of the external address bus, so the value $3 \times 4 = 12$ is stored in the register 65.

When twelve data bits have been output, the output of the up-counter 66 matches the value stored in the register 65. Detecting this match, the match detecting circuit 67 generates a fourth internal control signal that forthwith halts the address counting means 18 and commands the input/output control circuit 36 to place the input/output circuit 53 in the high-impedance state.

At an appropriate later time the processor drives $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$ high, ending the first access cycle. To access the second twelve bits, the processor next drives $\overline{\text{RAS}}$ low and sends a new row address X_2 , then drives $\overline{\text{CAS}}$ low and sends a new column address. These new addresses are latched at times t_3 and t_4 , respectively, and output of the data starting at address (X_2, Y_2) begins. At time t_6 the processor does not have to send the block count ($N = 3$) again, because the old count is still held in the register 65. Accordingly, the processor continues to hold $\overline{\text{CAS}}$ low from time t_5 until the end of the access cycle. Once again, the memory outputs twelve bits, then halts output and places the input/output circuit 53 in the high-impedance state.

Write access is similar to read access except that $\overline{\text{WE}}$ is driven low instead of $\overline{\text{OE}}$.

The fifth novel memory provides the same advantages as the fourth, with the further advantage that when a processor performs repeated burst accesses of the same length, it only has to specify the length once. A further advantage is that if a processor neglects to specify an access length, because of a programming error for example, this will not in general cause the memory to attempt a burst access of the maximum length, because the previous length will be stored in the register 65 as a default value.

Fig. 12 is a block diagram of a sixth novel synchronous burst-access memory that combines the features of the third and fourth novel memories. Elements identical to elements in Fig. 8 are identified by the same reference numerals.

The sixth novel memory, like the fourth novel memory, has an access counting means 60 comprising a down-counter 61 for counting accesses and halting input or output when a requested count is reached.

The address buffer 31 in Fig. 12 is divided into a

first buffer 68 and a second buffer 69. The first buffer 68 supplies a row address to the row address decoder 41 and a column address to the address counting means 18; the second buffer 69 supplies the value on the address bus ADD to the access counting means 60. These operations are performed as already described.

A disabling circuit 70 receives the clock signal CLK, sends control signals to the second buffer 69 and the memory control signal generating circuit 32, and receives a control signal from the memory control signal generating circuit 32. The disabling circuit 70 comprises, for example, a simple counter circuit. The function of the disabling circuit 70 is to enable the access counting means 60 to receive the value on the address bus only during a certain interval after $\overline{\text{CAS}}$ first becomes active following activation of $\overline{\text{RAS}}$.

When $\overline{\text{CAS}}$ goes low for the first time after $\overline{\text{RAS}}$ goes low, the memory control signal generating circuit 32 notifies the disabling circuit 70. On the first rising edge of CLK thereafter, the disabling circuit 70 enables the second buffer 69, activates a control signal P_z sent to the memory control signal generating circuit 32, and starts counting CLK cycles. When a certain count (three for example) is reached, the disabling circuit 70 disables the second buffer 69 and deactivates P_z . Here P_z is active high.

The sixth novel memory has a clock control circuit 58 similar to the one in the third novel memory for blocking clock input to the address counting means 18, the input/output control circuit 36, the input/output circuit 53, and the access counting means 60. The control signal sent from the memory control signal generating circuit 32 to the clock control circuit 58 is not $\overline{\text{CAS}}$, however, but a signal that blocks CLK only if $\overline{\text{CAS}}$ goes high while P_z is low. This signal can be generated, for example, by an AND gate 71 having $\overline{\text{CAS}}$ and the inverse of P_z as inputs.

The memory cell array in Fig. 12 has the structure shown in Fig. 13A. Access to the two blocks comprising data D_1 to D_8 in Fig. 13A will be illustrated next.

Referring to Fig. 13B, access begins as in the fourth and fifth novel memories, the row address X_1 being latched at time t_1 and the column address Y_1 being preset in the address counting means 18 at time t_2 . At time t_2 the disabling means 70 enables the second buffer 69, permitting the block access count ($N = 2$) to be transferred to the access counting means 60 at time t_3 . Also at time t_2 , the disabling means 70 drives the P_z signal high and starts counting CLK cycles.

$\overline{\text{CAS}}$ goes high for one clock cycle between times t_2 and t_3 , but since P_z is high, $\overline{\text{CAS}}$ does not block CLK. The address counting means increments normally, and data output begins with D_1 . Data output continues with D_2 and D_3 while $\overline{\text{CAS}}$ goes low again.

After counting three CLK cycles, the disabling means 70 drives the P_z signal low, permitting CLK to be gated by $\overline{\text{CAS}}$. Accordingly, if $\overline{\text{CAS}}$ subsequently goes high, as it does for three clock cycles around time t_4 for

example, the address counting means 18 stops incrementing between times t_4 and t_5 . During this interval the access counting means 60 also stops counting, the I/O port is placed in the high-impedance state on command from the memory control signal generating circuit 32, and access pauses.

Access resumes after time t_5 , this being the first rising edge of CLK after CAS goes low again, and the remaining data D_4, \dots, D_8 are output. When D_8 has been output, the access counting means 60 terminates the access by stopping the address counting means 18 and causing the I/O port to be placed in the high-impedance state again.

The sixth novel memory has the advantages of both the third and fourth novel memories: access can be temporarily halted by driving CAS high in order to allow another device to use the data bus; the data bus is released promptly when the requested number of bits have been accessed; and in write access, the access count can be used to mask bits in image-processing operations such as clip and fill.

Fig. 14 is a block diagram of a seventh novel synchronous burst-access memory. Elements identical to elements in Fig. 8 are identified by the same reference numerals.

This seventh novel memory is similar to the fourth novel memory but has an additional flag output circuit 72 that also receives the signal output by the access clock counting means 60 on the signal line 64 when the requested number of accesses have been performed. On receiving this signal, the flag output circuit 72 asserts an external flag signal denoted FLAG in the drawings to notify external devices that the burst access has ended. The flag output circuit comprises, for example, a flip-flop circuit that is set by the signal from the access counting means 60 and reset (via a signal line not shown in the drawing) when RAS goes high.

The operation of the seventh novel memory, illustrated in Fig. 15, is identical to the operation of the fourth novel memory illustrated in Fig. 9B with the addition of the flag output signal which goes high when a burst access is completed.

The advantage of the seventh novel memory is that a processor can delegate memory access to a memory management unit and execute other operations without having to count accessed bits. At the completion of memory access, the flag signal notifies the processor (or other external devices) that the memory is available to begin the next burst access.

Fig. 16 is a block diagram of an eighth novel synchronous burst-access memory. Elements identical to elements in Fig. 14 are identified by the same reference numerals.

The access counting means 60 in Fig. 16 is adapted to generate a signal Pend that goes active a certain number of CLK cycles before the requested number of accesses have been completed. If the access counting means comprises a down-counter 61, for example, the

Pend signal can be generated when a certain positive count is reached, this count being higher than the count value indicating completion of access.

The Pend signal is sent to a flag shifting circuit 73 and delayed by a certain time, the length of the delay being controlled, for example, by an externally input shift control signal denoted SFT. The delayed signal, denoted PfSft in the drawings, is sent to the flag output circuit 72 and causes output of the flag signal.

Fig. 17 is a schematic diagram of the flag shifting circuit 73 in Fig. 16, also showing the flag output circuit 72.

This flag shifting circuit 73 comprises an n-clock delay circuit 80 that receives the Pend and CLK signals and delays Pend by n CLK cycles, a tri-state buffer 81 that inputs Pend, an inverter 82 that inverts SFT, and a tri-state buffer 83 that receives the output of the n-clock delay circuit 80. The tri-state buffer 83 is enabled by the SFT signal; the tri-state buffer 81 is enabled by the inverted SFT signal created by the inverter 82. When enabled, both tri-state buffers 81 and 83 act as inverters. The output of whichever tri-state buffer 81 or 83 is enabled is inverted again by an inverter 84 to generate the output signal PfSft which is sent to the flag output circuit 72.

Fig. 18 is a timing diagram for the flag shifting circuit in Fig. 17, showing the case in which n = 1. When SFT is low, PfSft lags Pend by only the slight propagation delay of the tri-state buffer 81 and the inverter 84. When SFT is high, however, PfSft lags Pend by substantially one CLK cycle, going high on the falling edge of CLK in the next CLK cycle after Pend goes high.

Figs. 19 and 20 illustrate the operation of the eighth novel memory when the access clock counter 63 is adapted to drive Pend high during the penultimate access, and the flag shifting circuit of Fig. 17 is used. In Fig. 19 SFT is high, so flag output is delayed and occurs when access is actually completed. In Fig. 20 SFT is low, so flag output occurs one CLK cycle earlier.

To take prompt advantage of the availability of the data bus, some processors may need to be notified one or more clock cycles before the bus becomes available. The eighth novel memory is useful in such cases. Control of the timing of the notification (FLAG signal output) by the SFT input signal enables the memory to be easily adapted to the timing requirements of different processors.

Instead of having an externally input signal (SFT) select the Pend-to-FLAG delay, it is possible to make this selection on a permanent basis when the memory device is fabricated. The selection can be made by a manufacturing option such as a metalization mask option, laser trimming option, or bonding option.

It will be apparent that the features of the second through eighth novel memories can be combined in ways other than those shown above. The clock-frequency-dividing feature of the second novel memory, for example, can be added to any of the other novel memo-

ries, and the temporary access halting feature of the sixth novel memory can be combined with the flag output feature of the seventh novel memory, or the shifted flag output feature of the eighth novel memory.

The preceding description has dealt mainly with matters related to the column address strobe signal \overline{CAS} , column address, and access count, but a synchronous, high-speed burst-access memory using DRAM memory cells also requires novel circuitry for row-address latching and word-line driving. A novel word-line driving circuit, applicable to synchronous DRAM in general, will be described next with reference to Fig. 21.

The word-line driving circuit in Fig. 21 receives the clock signal CLK, the row address strobe signal \overline{RAS} , and address signals (A_0, \dots, A_k) from the external address bus ADD. A clock generating circuit 100 combines CLK and \overline{RAS} to generate an address latch clock signal Pa that becomes active when CLK and \overline{RAS} are both active, and remains active until \overline{RAS} becomes inactive. Pa and CLK are active high, and \overline{RAS} is active low.

The clock generating circuit 100 in Fig. 21 comprises, for example, an inverter 101 that receives and inverts \overline{RAS} , an AND gate 102 that ANDs the inverted \overline{RAS} signal from the inverter 101 with the clock signal CLK, and a flip-flop circuit 103 having set and reset input terminals. The set terminal (marked S in the drawing) receives the output of the AND gate 102. The reset terminal (marked R) receives \overline{RAS} . The output of the flip-flop circuit 103 goes high when the S input is high and the R input is low, remains unchanged while the S and R inputs are both low, and goes low when the S input is low and the R input is high. Transitions in the output of the flip-flop circuit 103 are synchronized with the rising edge of the clock signal CLK, which is supplied to a clock input terminal of the flip-flop 103.

The clock generating circuit 100 need not be structured as shown in Fig. 21. Other circuit configurations can be used instead.

The word-line driving circuit in Fig. 21 also has a first transparent latch circuit 104 and a second transparent latch circuit 105. A transparent latch is a circuit having a data input, a clock input and a data output. While the clock input is inactive (low in the present case), the data output changes according to the data input. When the clock input becomes active (goes high in the present case), the data output latches at its current value and remains unchanged as long as the clock input stays active.

The first transparent latch circuit 104 receives \overline{RAS} as its data input and CLK as its clock input, and generates a first internal signal Pb as its data output. Pb and \overline{RAS} have opposite polarity, Pb going high when \overline{RAS} goes low and vice versa.

The second transparent latch circuit 105 receives the address signals A_0, \dots, A_k as its data input and Pa as its clock input. The second transparent latch circuit 105 accordingly comprises a plurality of one-bit latches that are clocked in parallel by Pa.

The output of the second transparent latch circuit 105 is supplied via an address generating circuit 106 to a word-line decoding circuit 110. The address generating circuit 106 transfers the output of the second transparent latch circuit 105 to the word-line decoding circuit 110 as a row address (ADX).

The word-line decoding circuit 110 decodes the row address ADX, selects one of a plurality of word lines WL_0 to WL_n , and generates a second internal signal Pc that becomes active when a word line has been selected. In Fig. 21 the word-line decoding circuit 110 comprises an X-decoder 111 that decodes the row address ADX and provides output signals to a NOR gate 112 and a plurality of AND gates 113₀, ..., 113_n. The output signals W_0, \dots, W_n provided to the AND gates 113₀, ..., 113_n are the decoded address: as a result of decoding, the X-decoder 111 drives just one of the signals W_0, \dots, W_n high. The signal X provided to the NOR gate 112 is active low and signifies that the decoding operation has been completed; the signal X can be obtained from the signals W_0, \dots, W_n by NOR logic, for example.

The NOR gate 112 performs NOR logic on the signal X and a signal \overline{RAS} a having the same polarity as \overline{RAS} . The output of the NOR gate 112 is the second internal signal Pc, which thus goes high when \overline{RAS} is low and the decoded address is valid, indicating that a word line has been selected.

The word-line decoding circuit 110 need not be structured as shown in Fig. 21. Other circuit configurations are also possible.

The first internal signal Pb, the second internal signal Pc, and a control signal are supplied to a gating and driving circuit 120. In Fig. 21 the control signal is the address latch clock signal Pa. The gating and driving circuit 120 gates the first internal signal Pb according to the second internal signal Pc and the control signal Pa to generate a drive signal Pd, which drives the word-line selected by the word-line decoding circuit 110.

The gating and driving circuit 120 in Fig. 21 comprises a three-input AND gate 121 and a word-line driver 122. The AND gate 121 receives Pa, Pb, and Pc as inputs, carries out a logical AND operation on these inputs, and sends the resulting output to the word-line driver 122. The drive signal Pd generated by the word-line driver 122 has the same polarity as the signal received from the AND gate 121. Pd is supplied to the AND gates 113₀, ..., 113_n in the word-line decoding circuit 110, and drives the word line WL_i for which the corresponding signal W_i from the X-decoder 111 is high.

The gating and driving circuit 120 need not be structured as shown in Fig. 21. For example, a control signal other than Pa can be used as the third input to the AND gate 121, or the output of the AND gate 121 can be used directly as the drive signal Pd, eliminating the word-line driver 122.

The operation of the word-line driving circuit in Fig. 21 will be described with reference to the timing diagram in Fig. 22.

At the beginning of Fig. 22 the address latch clock signal Pa, the first and second internal signals Pb and Pc, and the drive signal Pd are all inactive (low). No word line is driven: WL₀, ..., WL_n are all low. The outputs W₀, ..., W_n of the X-decoder 111 are in an invalid state.

To begin an access cycle RAS is driven low and a valid row address is placed on the address bus ADD. RAS and ADD must satisfy setup times Trs and Tas with respect to the rising edge of CLK. Trs and Tas must be long enough for row address decoding to be completed and the first and second internal signals Pb and Pc to become active before the rise of CLK at time t₃. In Fig. 21 RAS goes low and ADD becomes valid before the preceding falling edge of CLK, but this is not a necessary condition. For example, RAS and ADD input can be synchronized with the falling edge of CLK, as shown in earlier timing diagrams such as Fig. 2.

After RAS becomes active (goes low) at time t₁ in Fig. 22, when CLK goes low to unlatch the first transparent latch circuit 104, the first internal signal Pb likewise becomes active (goes high). In the meantime, since Pa is low the second transparent latch circuit 105 is unlatched and passes the row address from the address bus ADD via the address generating circuit 106 to the X-decoder 111.

At a time t₂ prior to t₃, the X-decoder finishes decoding the row address and drives just one of the signals W₀, ..., W_n to the high state. In Fig. 22, W₂ is driven high. At this time the second internal signal Pc also goes high, signifying that row address decoding and word-line selection have been completed. The word-line decoding device is now ready to drive the selected word line as soon as CLK rises.

When CLK rises at time t₃ the address latch clock signal Pa goes high, closing the second transparent latch circuit 105. The row address on the address bus ADD can now be replaced with another address, such as a column address, without changing the selected word line. In addition, since all three inputs to the AND gate 121 are high, the drive signal Pd goes high, driving the selected word line WL₂ high.

The use of transparent latches for RAS and the address signals enables row address decoding to be advanced into the clock cycle preceding the time t₃ at which RAS and the row address are latched. Word-line driving therefore begins almost immediately after the rise of CLK, the only delay being the short propagation delay of the AND gates 113₂ and 121 and of the word-line driver 122.

Although word-line driving is synchronized with the rising edge of CLK in Fig. 22, it can of course be synchronized with the falling edge by using transparent latches that close when CLK is low, and making other obvious modifications to the circuits in Fig. 21.

Claims

1. A synchronous burst-access memory to receive a clock signal, a row address strobe signal, a column address strobe signal, and address signals, comprising:

a memory cell array for storing data in memory cells disposed in intersecting rows and columns;

latching means for latching the row address strobe signal, the column address strobe signal, and the address signals in synchronization with the clock signal, and for generating first and second internal control signals from the latched signals;

input/output means, coupled to said latching means, for external input and output of data in synchronization with said clock signal;

row address decoding means, coupled to said memory cell array, for decoding said address signals and selecting a row of memory cells in said memory cell array in response to the first internal control signal;

address counting means, preset to a value determined by said address signals in response to the second internal control signal, for counting said clock signal and generating a consecutive series of column addresses starting from the preset value;

column address decoding means coupled to said address counting means, for decoding said series of column addresses and selecting corresponding columns in said memory cell array; and

data transfer means coupled to said memory cell array, said input/output means, and said address counting means, for transferring data from said input/output means to said memory cell array and from said memory cell array to said input/output means, data being transferred to and from memory cells disposed in columns selected by said column address decoding means in the row selected by said row address decoding means,

wherein the first internal control signal in said memory is directly generated by the row address strobe signal and the clock signal, and the second internal control signal in said memory is directly generated by the column address strobe signal and the clock signal and applied to the address counting means.

2. The memory of claim 1, wherein said first internal control signal is generated from said row address strobe signal and said clock signal.
3. The memory of claim 1, wherein said second inter-

- nal control signal is generated from said column address strobe signal and said clock signal.
4. The memory of claim 1, wherein said memory cells are dynamic memory cells. 5
5. The memory of claim 1, also comprising frequency-dividing means for dividing said clock signal in frequency before said clock signal is supplied to said latching means, said address counting means, and said input/output means. 10
6. The memory of claim 5, wherein said frequency-dividing means divides the frequency of said clock signal by an amount selected by an external control signal. 15
7. The memory of claim 5, wherein said frequency-dividing means divides the frequency of said clock signal by an amount selected by a manufacturing option. 20
8. The memory of claim 1, also comprising clock control means coupled to said latching means, for blocking input of said clock signal to said address counting means and said input/output means while said column address strobe signal is inactive. 25
9. The memory of claim 8, wherein said clock control means comprises an OR gate having said clock signal and said column address strobe signal as inputs. 30
10. The memory of claim 8, wherein said latching means generates a third internal control signal causing said input/output means to cease input and output when said column address strobe signal is inactive. 35
11. The memory of claim 1, also comprising access counting means, coupled to said address counting means and said input/output means, for counting said clock signal and generating a fourth internal control signal when a certain number of clock signals have been counted, said fourth internal control signal commanding said address counting means to cease generating column addresses and said input/output means to cease input and output. 40
12. The memory of claim 11, wherein said number is determined by said address signals. 50
13. The memory of claim 12, wherein said access counting means receives said number from said latching means in synchronization with said clock signal when said column address strobe signal becomes active for a second time after said row address strobe signal becomes active. 55
14. The memory of claim 12, wherein said access counting means comprises a down-counter preset according to said number, for generating said fourth internal control signal when a certain count is reached.
15. The memory of claim 12, wherein said access clock counting means comprises:
an up-counter for counting said clock signal, thus generating a count value;
a register for storing said number; and
a match-detecting circuit coupled to said counter and said register, for comparing said count value with contents of said register and generating said fourth control signal when said count value matches said contents of said register. 16. The memory of claim 13, further comprising disabling means coupled to said latching means, for enabling said access counting means to receive said number from said latching means only during a certain interval after said column address strobe signal first becomes active following activation of said row address strobe signal. 20
17. The memory of claim 16, wherein said disabling means determines said interval by counting said clock signal. 25
18. The memory of claim 16, further comprising clock control means coupled to said latching means, for blocking input of said clock signal to said address counting means and said input/output means when said column address strobe signal is inactive before and after but not during said interval. 30
19. The memory of claim 11, also comprising flag output means coupled to said access counting means, for generating a flag signal indicating completion of access. 35
20. The memory of claim 19, wherein said flag signal is generated when said access counting means has counted said number of clock signals. 40
21. The memory of claim 19, wherein said flag signal is generated a certain time before said access counting means has counted said number of clock signals. 45
22. The memory of claim 19, wherein said flag output means has flag shifting means for delaying output of said flag signal by a selectable amount of time. 50
23. The memory of claim 22, wherein said amount of time is selected by a manufacturing option. 55

24. The memory of claim 22, wherein said amount of time is selected by an external shift control signal.
25. The memory of claim 24, wherein said access clock counting means generates an ending signal a certain time before said number of clock signals have been counted, and said flag shifting means comprises:

a first tri-state buffer for receiving said ending signal from said access clock counting means and outputting same in response to said shift control signal;
 a delay line for receiving said ending signal from said access clock counting means and generating a delayed ending signal;
 a second tri-state buffer coupled to said delay line, for receiving said delayed ending signal from said delay line and outputting same in response to said shift control signal; and
 an inverter coupled to said first tri-state buffer and said second tri-state buffer, for -inverting said shift control signal at a point between said first tri-state buffer and said second-tri-state buffer.

26. The memory of any one of the preceding claims, further including a word-line driving circuit that receives a clock signal, a row address strobe signal, and address signals, for driving word lines in said synchronous dynamic memory, comprising:

a clock generating circuit for generating an address latch clock signal that becomes active when the row address strobe signal and the clock signal are both active, and remains active until said row address strobe signal becomes inactive;
 a first transparent latch circuit, clocked by said clock signal, for latching said row address strobe signal and generating therefrom a first internal signal;
 a second transparent latch circuit, coupled to said clock generating circuit and clocked by said address latch clock signal, for latching the address signals;
 an address generating circuit, coupled to said second transparent latch circuit, for generating a row address from an output of said second transparent latch circuit;
 a word-line decoding circuit coupled to said address generating circuit, for decoding said row address, thus selecting one word line, and generating a second internal signal that becomes active when said word line has been selected; and
 gating and driving means coupled to said first transparent latch circuit and said word-line de-

coding circuit, for receiving a control signal, gating said first internal signal according to said second internal signal and said control signal to generate a drive signal, and driving the selected word line by said drive signal.

- 5 27. The circuit of claim 26, wherein said address latch clock signal is used as said control signal.
- 10 28. The circuit of claim 26, wherein said gating and driving means comprises:

15 a three-input AND gate having said first input signal, said second input signal, and said control signal as inputs; and
 a word-line driver coupled to said three-input AND gate, for generating said drive signal from output of said three-input AND gate.

20 **Patentansprüche**

1. Synchronisierte Burstzugriffsspeicher, der ein Taktsignal, ein Zeilenadreß-Strobe-Signal, ein Spaltenadreß-Strobe-Signal und Adreß-Signale empfängt, wobei der Burstzugriffsspeicher die folgenden Merkmale aufweist:

30 eine Speicherzellenmatrix zum Speichern von Daten in Speicherzellen, die in sich kreuzenden Zeilen und Spalten angeordnet sind;
 eine Zwischenspeichereinrichtung zum Zwischenspeichern des Zeilenadreß-Strobe-Signals, des Spaltenadreß-Strobe-Signals und der Adreß-Signale synchron mit dem Taktignal und zum Erzeugen eines ersten und eines zweiten internen Steuersignals aus den zwischengespeicherten Signalen;
 eine mit der Zwischenspeichereinrichtung gekoppelte Eingabe/Ausgabe-Einrichtung zur externen Eingabe und Ausgabe von Daten synchron mit dem Taktignal;
 eine mit der Speicherzellenmatrix gekoppelte Zeilenadreß-Dekodiereinrichtung zum Dekodieren der Adreß-Signale und zum Auswählen einer Zeile von Speicherzellen in der Speicherzellenmatrix, und zwar als Antwort auf das erste interne Steuersignal;
 eine als Antwort auf das zweite interne Steuer-Signal auf einen durch die Adreß-Signale bestimmten Wert voreingestellte Adreß-Zähleinrichtung zum Zählen des Taktsignals und zum Erzeugen einer aufeinanderfolgenden Serie von Spaltenadressen, und zwar beginnend beim voreingestellten Wert;
 eine mit der Adreß-Zähleinrichtung gekoppelte Spaltenadreß-Dekodiereinrichtung zum Dekodieren der Serie von Spaltenadressen und zum

- Auswählen entsprechender Spalten in der Speicherzellenmatrix; und eine mit der Speicherzellenmatrix, mit der Eingabe/Ausgabe-Einrichtung und mit der Adreß-Zähleinrichtung gekoppelte Datentransfereinrichtung zum Übertragen von Daten von der Eingabe/Ausgabe-Einrichtung zu der Speicherzellenmatrix und von der Speicherzellenmatrix zu der Eingabe/Ausgabe-Einrichtung, wobei Daten zu und von den Speicherzellen übertragen werden, die in von der Spaltenadreß-Dekodiereinrichtung ausgewählten Spalten und in der von der Zeilenadreß-Dekodiereinrichtung ausgewählten Zeile angeordnet sind,
wobei das erste interne Steuersignal in dem Speicher direkt durch das Zeilenadreß-Strobe-Signal und das Taktsignal erzeugt wird, und wobei das zweite interne Steuersignal in dem Speicher direkt durch das Spaltenadreß-Strobe-Signal und das Taktsignal erzeugt wird und an die Adreß-Zähleinrichtung angelegt wird.
2. Speicher nach Anspruch 1, bei dem das erste interne Steuersignal aus dem Zeilenadreß-Strobe-Signal und aus dem Taktsignal erzeugt wird. 25
3. Speicher nach Anspruch 1, bei dem das zweite interne Steuersignal aus dem Spaltenadreß-Strobe-Signal und aus dem Taktsignal erzeugt wird. 30
4. Speicher nach Anspruch 1, bei dem die Speicherzellen dynamische Speicherzellen sind. 35
5. Speicher nach Anspruch 1, der auch eine Frequenzteilungseinrichtung zum Teilen der Frequenz des Taktsignals aufweist, bevor das Taktsignal an die Zwischenspeichereinrichtung, an die Adreß-Zähleinrichtung und an die Eingabe/Ausgabe-Einrichtung geliefert wird. 40
6. Speicher nach Anspruch 5, bei dem die Frequenzteilungseinrichtung die Frequenz des Taktsignals durch einen durch ein externes Steuersignal ausgewählten Betrag teilt. 45
7. Speicher nach Anspruch 5, bei dem die Frequenzteilungseinrichtung die Frequenz des Taktsignals durch einen durch eine Herstellungsoption ausgewählten Betrag teilt. 50
8. Speicher nach Anspruch 1, der auch eine mit der Zwischenspeichereinrichtung gekoppelte Takt-Steuereinrichtung aufweist, und zwar zum Blockieren der Eingabe des Taktsignals an die Adreß-Zähleinrichtung und an die Eingabe/Ausgabe-Einrichtung, während das Spaltenadreß-Strobe-Signal inaktiv ist. 55
9. Speicher nach Anspruch 8, bei dem die Takt-Steuereinrichtung ein OR-Gatter aufweist, das das Takt-Signal und das Spaltenadreß-Strobe-Signal als Eingänge aufweist. 5
10. Speicher nach Anspruch 8, bei dem die Zwischenspeichereinrichtung ein drittes internes Steuersignal erzeugt, das die Eingabe/Ausgabe-Einrichtung dazu veranlaßt, die Eingabe und die Ausgabe zu beenden, wenn das Spaltenadreß-Strobe-Signal inaktiv ist. 10
11. Speicher nach Anspruch 1, der auch eine mit der Adreß-Zähleinrichtung und der Eingabe/Ausgabe-Einrichtung gekoppelte Zugriffs-Zähleinrichtung aufweist, und zwar zum Zählen des Taktsignals und zum Erzeugen eines vierten internen Steuersignals, wenn eine bestimmte Anzahl von Taktignalen gezählt worden ist, wobei das vierte interne Steuersignal der Adreß-Zähleinrichtung befiehlt, die Erzeugung von Spaltenadressen zu beenden, und wobei das vierte interne Steuersignal der Eingabe/Ausgabe-Einrichtung befiehlt, die Eingabe und die Ausgabe zu beenden. 15
12. Speicher nach Anspruch 11, bei dem die Anzahl durch die Adreß-Signale bestimmt ist. 20
13. Speicher nach Anspruch 12, bei dem die Zugriffs-Zähleinrichtung die Anzahl synchron mit dem Takt-Signal von der Zwischenspeichereinrichtung empfängt, wenn das Spaltenadreß-Strobe-Signal für eine zweite Zeit aktiv wird, nachdem das Zeilenadreß-Strobe-Signal aktiv wird. 25
14. Speicher nach Anspruch 12, bei dem die Zugriffs-Zähleinrichtung einen gemäß der Anzahl eingestellten Abwärtszähler aufweist, und zwar zum Erzeugen des vierten internen Steuersignals, wenn eine bestimmte Zählung erreicht wird. 30
15. Speicher nach Anspruch 12, bei dem die Zugriffstakt-Zähleinrichtung die folgenden Merkmale aufweist:
einen Aufwärtszähler zum Zählen des Taktsignals, wobei dadurch ein Zählwert erzeugt wird;

ein Register zum Speichern der Anzahl; und eine Übereinstimmungs-Erfassungsschaltung, die mit dem Zähler und dem Register gekoppelt ist, und zwar zum Vergleichen des Zählwertes mit Inhalten des Registers und zum Erzeugen des vierten Steuersignals, wenn der Zählwert mit dem Inhalt des Registers übereinstimmt. 35
16. Speicher nach Anspruch 13, der weiterhin eine Sperreinrichtung aufweist, die mit der Zwischenspeichereinrichtung gekoppelt ist, und zwar zum 40

- Freigeben der Zugriffs-Zähleinrichtung, um die Anzahl von der Zwischenspeichereinrichtung nur während eines bestimmten Intervalls zu empfangen, nachdem das Spaltenadreß-Strobe-Signal nach der Aktivierung des Zeilenadreß-Strobe-Signals erstmals aktiv wird. 5
17. Speicher nach Anspruch 16, bei dem die Sperreinrichtung das Intervall durch Zählen des Taktsignals bestimmt. 10
18. Speicher nach Anspruch 16, der weiterhin eine Takt-Steuereinrichtung aufweist, die mit der Zwischenspeichereinrichtung gekoppelt ist, und zwar zum Blockieren der Eingabe des Taktsignals an die Adreß-Zähleinrichtung und die Eingabe/Ausgabe-Einrichtung, wenn das Spaltenadreß-Strobe-Signal vor und nach, jedoch nicht während dieses Intervalls inaktiv ist. 15
19. Speicher nach Anspruch 11, der auch eine mit der Zugriffs-Zähleinrichtung gekoppelte Flag-Ausgabe-einrichtung zum Erzeugen eines den Abschluß eines Zugriffs anzeigen den Flag-Signals aufweist. 20
20. Speicher nach Anspruch 19, bei dem das Flag-Signal erzeugt wird, wenn die Zugriffs-Zähleinrichtung die Anzahl von Taktsignalen gezählt hat. 25
21. Speicher nach Anspruch 19, bei dem das Flag-Signal eine bestimmte Zeit vor dem Zählen der Anzahl von Taktsignalen durch die Zugriffs-Zähleinrichtung erzeugt wird. 30
22. Speicher nach Anspruch 19, bei dem die Flag-Ausgabeeinrichtung eine Flag-Schiebeeinrichtung zum Verzögern der Ausgabe des Flag-Signals um eine wählbare Zeitdauer aufweist. 35
23. Speicher nach Anspruch 22, bei dem die Zeitdauer durch eine Herstellungsoption ausgewählt ist. 40
24. Speicher nach Anspruch 22, bei dem die Zeitdauer durch ein externes Schiebe-Steuersignal ausgewählt ist. 45
25. Speicher nach Anspruch 24, bei dem die Zugriffstakt-Zähleinrichtung ein Ende-Signal erzeugt, und zwar zu einem bestimmten Zeitpunkt, bevor die Anzahl von Taktsignalen gezählt worden ist, und bei dem die Flag-Schiebeeinrichtung die folgenden Merkmale aufweist: 50
- einen ersten Dreizustandspuffer zum Empfangen des Ende-Signals von der Zugriffstakt-Zähleinrichtung und zum Ausgeben desselben als Antwort auf das Schiebe-Steuersignal; 55
- eine Verzögerungsleitung zum Empfangen des Ende-Signals von der Zugriffstakt-Zähleinrichtung und zum Erzeugen eines verzögerten Ende-Signals;
- einen mit der Verzögerungsleitung gekoppelten zweiten Dreizustandspuffer zum Empfangen des verzögerten Ende-Signals von der Verzögerungsleitung und zum Ausgeben desselben als Antwort auf das Schiebe-Steuersignal; und
- einen mit dem ersten Dreizustandspuffer und mit dem zweiten Dreizustandspuffer gekoppelten Inverter zum Invertieren des Schiebe-Steuersignals an einem Punkt zwischen dem ersten Dreizustandspuffer und dem zweiten Dreizustandspuffer.
26. Speicher gemäß einem der vorhergehenden Ansprüche, der weiterhin eine Wortleitungs-Treiberschaltung aufweist, die ein Taktignal, ein Zeilenadreß-Strobe-Signal und Adreß-Signale empfängt, und zwar zum Ansteuern von Wortleitungen in dem synchronisierten dynamischen Speicher, wobei die Schaltung die folgenden Merkmale aufweist:
- eine Taktzeugungsschaltung zum Erzeugen eines Adreßzwischenspeicher-Taktsignals, das aktiv wird, wenn das Zeilenadreß-Strobe-Signal und das Taktignal beide aktiv sind, und das aktiv bleibt, bis das Zeilenadreß-Strobe-Signal inaktiv wird;
- eine durch das Taktignal getaktete erste transparente Zwischenspeicherschaltung zum Zwischenspeichern des Zeilenadreß-Strobe-Signals und zum Erzeugen eines ersten internen Signals daraus;
- eine mit der Taktzeugungsschaltung gekoppelte und mit dem Adreßzwischenspeicher-Taktsignal getaktete zweite transparente Zwischenspeicherschaltung zum Zwischenspeichern der Adreß-Signale;
- eine mit der zweiten transparenten Zwischenspeicherschaltung gekoppelte Adreßzeugungsschaltung zum Erzeugen einer Zeilenadresse aus einer Ausgabe der zweiten transparenten Zwischenspeicherschaltung;
- eine mit der Adreßzeugungsschaltung gekoppelte Wortleitungsdekodierschaltung zum Dekodieren der Zeilenadresse, wobei dadurch eine Wortleitung ausgewählt wird, und zum Erzeugen eines zweiten internen Signals, das aktiv wird, wenn die Wortleitung ausgewählt worden ist, und
- eine mit der ersten transparenten Zwischenspeicherschaltung und mit der Wortleitungsdekodierschaltung gekoppelte Gatter- und Ansteuereinrichtung zum Empfangen eines Steuersignals, wobei das erste interne Signal gemäß dem zweiten internen Signal und gemäß

dem Steuersignal gesteuert wird, um ein Ansteuer-Signal zu erzeugen, und wobei die ausgewählte Wortleitung durch das Ansteuer-Signal angesteuert wird.

5

27. Schaltung nach Anspruch 26, bei der das Adreßzwischenspeicher-Taktsignal als Steuersignal verwendet wird.

28. Schaltung nach Anspruch 26, bei der die Gatter- und Ansteuereinrichtung die folgenden Merkmale aufweist:

ein AND-Gatter mit drei Eingängen mit dem ersten Eingabesignal, dem zweiten Eingabesignal und dem Steuersignal als Eingaben; und einen mit dem AND-Gatter mit drei Eingängen gekoppelten Wortleitungstreiber zum Erzeugen des Ansteuer-Signals aus der Ausgabe des AND-Gatters mit drei Eingängen.

15

20

des moyens de décodage d'adresse de colonne reliés auxdits moyens de comptage d'adresse, pour décoder ladite série d'adresses de colonne et pour sélectionner des colonnes correspondantes dans ledit groupement de cellules de mémoire ; et

des moyens de transfert de données reliés audit groupement de cellules de mémoire, auxdits moyens d'entrée/sortie, et auxdits moyens de comptage d'adresse, pour transférer les données depuis lesdits moyens d'entrée/sortie vers ledit groupement de cellules de mémoire et depuis ledit groupement de cellules de mémoire vers lesdits moyens d'entrée/sortie, les données étant transférées vers et en provenance des cellules de mémoire agencées en colonnes sélectionnées par lesdits moyens de décodage d'adresse de colonne dans la ligne sélectionnée par lesdits moyens de décodage d'adresse de ligne,

dans laquelle le premier signal interne de commande dans ladite mémoire est directement produit par le signal d'activation d'adresse de ligne et par le signal d'horloge, et le second signal interne de commande dans ladite mémoire est directement produit par le signal d'activation d'adresse de colonne et par le signal d'horloge et est appliqué aux moyens de comptage d'adresse.

Revendications

1. Mémoire synchrone à accès en salves pour recevoir un signal d'horloge, un signal d'activation d'adresse de ligne, un signal d'activation d'adresse de colonne, et des signaux d'adresse, comprenant :

25

un groupement de cellules de mémoire pour stocker des données dans des cellules de mémoire agencées en lignes et en colonnes qui se coupent ;

30

des moyens de mémorisation pour mémoriser le signal d'activation d'adresse de ligne, le signal d'activation d'adresse de colonne, et les signaux d'adresse, en synchronisation avec le signal d'horloge, et pour produire des premier et second signaux internes de commande à partir des signaux mémorisés ;

35

des moyens d'entrée/sortie, reliés auxdits moyens de mémorisation, pour l'entrée et la sortie externes de données en synchronisation avec ledit signal d'horloge ;

40

des moyens de décodage d'adresse de ligne, reliés audit groupement de cellules de mémoire, pour décoder lesdits signaux d'adresse et pour sélectionner une ligne de cellules de mémoire dans ledit groupement de cellules de mémoire en réponse au premier signal interne de commande ;

45

des moyens de comptage d'adresse, prérglés à une valeur déterminée par lesdits signaux d'adresse en réponse au second signal interne de commande, pour compter ledit signal d'horloge et pour produire une série consécutive d'adresses de colonne en partant de la valeur prérglée ;

50

2. Mémoire selon la revendication 1, dans laquelle ledit premier signal interne de commande est produit à partir dudit signal d'activation d'adresse de ligne et dudit signal d'horloge.

3. Mémoire selon la revendication 1, dans laquelle ledit second signal interne de commande est produit à partir dudit signal d'activation d'adresse de colonne et dudit signal d'horloge.

4. Mémoire selon la revendication 1, dans laquelle lesdites cellules de mémoire sont des cellules de mémoire dynamique.

5. Mémoire selon la revendication 1, comprenant également des moyens formant diviseur de fréquence pour diviser la fréquence dudit signal d'horloge avant que ledit signal d'horloge ne soit fourni auxdits moyens de mémorisation, auxdits moyens de comptage d'adresse, et auxdits moyens d'entrée/sortie.

6. Mémoire selon la revendication 5, dans laquelle lesdits moyens formant diviseur de fréquence divisent la fréquence dudit signal d'horloge par une quantité sélectionnée par un signal externe de commande.

7. Mémoire selon la revendication 5, dans laquelle les-

- dits moyens formant diviseur de fréquence divisent la fréquence dudit signal d'horloge par une quantité sélectionnée par une option de fabrication.
8. Mémoire selon la revendication 1, comprenant également des moyens de commande d'horloge reliés auxdits moyens de mémorisation, pour bloquer l'entrée dudit signal d'horloge dans lesdits moyens de comptage d'adresse et dans lesdits moyens d'entrée/sortie tandis que ledit signal d'activation d'adresse de colonne est inactif. 5
9. Mémoire selon la revendication 8, dans laquelle lesdits moyens de commande d'horloge comprennent une porte OU ayant ledit signal d'horloge et ledit signal d'activation d'adresse de colonne en tant qu'entrées. 10
10. Mémoire selon la revendication 8, dans laquelle lesdits moyens de mémorisation produisent un troisième signal interne de commande obligeant lesdits moyens d'entrée/sortie à cesser les entrées et les sorties lorsque ledit signal d'activation d'adresse de colonne est inactif. 15
11. Mémoire selon la revendication 1, comprenant également des moyens de comptage d'accès, reliés auxdits moyens de comptage d'adresse et auxdits moyens d'entrée/sortie, pour compter ledit signal d'horloge et pour produire un quatrième signal interne de commande quand un certain nombre de signaux d'horloge ont été comptés, ledit quatrième signal interne de commande commandant lesdits moyens de comptage d'adresse pour qu'ils cessent de produire des adresses de colonne et commandant lesdits moyens d'entrée/sortie pour qu'ils cessent les entrées et les sorties. 20
12. Mémoire selon la revendication 11, dans laquelle ledit nombre est déterminé par lesdits signaux d'adresse. 25
13. Mémoire selon la revendication 12, dans laquelle lesdits moyens de comptage d'adresse reçoivent ledit nombre à partir desdits moyens de mémorisation en synchronisation avec ledit signal d'horloge lorsque ledit signal d'activation d'adresse de colonne devient actif pour une seconde fois après que ledit signal d'activation d'adresse de ligne devient actif. 30
14. Mémoire selon la revendication 12, dans laquelle lesdits moyens de comptage d'accès comprennent un compteur régressif prétréglé selon ledit nombre, pour produire ledit quatrième signal interne de commande quand un certain comptage est atteint. 35
15. Mémoire selon la revendication 12, dans laquelle lesdits moyens de comptage d'horloge d'accès comprennent : 40
- un compteur progressif pour compter ledit signal d'horloge, produisant ainsi une valeur de comptage ;
 - un registre pour stocker ledit nombre ; et
 - un circuit de détection de concordance relié audit compteur et audit registre, pour comparer ladite valeur de comptage au contenu dudit registre et pour produire ledit quatrième signal de commande lorsque ladite valeur de comptage concorde avec ledit contenu dudit registre.
16. Mémoire selon la revendication 13, comprenant, de plus, des moyens d'invalidation reliés auxdits moyens de mémorisation, pour valider lesdits moyens de comptage d'accès pour recevoir ledit nombre en provenance desdits moyens de mémorisation seulement pendant un certain intervalle après que ledit signal d'activation d'adresse de colonne devient actif une première fois à la suite de l'activation dudit signal d'activation d'adresse de ligne. 45
17. Mémoire selon la revendication 16, dans laquelle lesdits moyens d'invalidation déterminent ledit intervalle en comptant ledit signal d'horloge. 50
18. Mémoire selon la revendication 16, comprenant, de plus, des moyens de commande d'horloge reliés auxdits moyens de mémorisation, pour bloquer l'entrée dudit signal d'horloge dans lesdits moyens de comptage d'adresse et dans lesdits moyens d'entrée/sortie lorsque ledit signal d'activation d'adresse de colonne est inactif avant et après, mais pas pendant, ledit intervalle. 55
19. Mémoire selon la revendication 11, comprenant également des moyens de sortie de drapeau reliés auxdits moyens de comptage d'accès, pour produire un signal de drapeau indiquant l'achèvement de l'accès. 60
20. Mémoire selon la revendication 19, dans laquelle ledit signal de drapeau est produit lorsque lesdits moyens de comptage d'accès ont compté ledit nombre de signaux d'horloge. 65
21. Mémoire selon la revendication 19, dans laquelle ledit signal de drapeau est produit un certain temps avant que lesdits moyens de comptage d'accès n'aient compté ledit nombre de signaux d'horloge. 70
22. Mémoire selon la revendication 19, dans laquelle lesdits moyens de sortie de drapeau possèdent des moyens de décalage de drapeau pour retarder la sortie dudit signal de drapeau d'une quantité de 75

- temps pouvant être sélectionnée.
- 23. Mémoire selon la revendication 22, dans laquelle ladite quantité de temps est sélectionnée par une option de fabrication.** 5
- 24. Mémoire selon la revendication 22, dans laquelle ladite quantité de temps est sélectionnée par un signal externe de commande de décalage.** 10
- 25. Mémoire selon la revendication 24, dans laquelle lesdits moyens de comptage d'horloge d'accès produisent un signal de terminaison un certain temps avant que ledit nombre de signaux d'horloge n'ait été compté, et dans laquelle lesdits moyens de décalage de drapeau comprennent :**
- un premier organe tampon à trois états pour recevoir ledit signal de terminaison en provenance desdits moyens de comptage d'horloge d'accès et pour sortir ce dernier en réponse audit signal de commande de décalage ; 20
- une ligne à retard pour recevoir ledit signal de terminaison en provenance desdits moyens de comptage d'horloge d'accès et pour produire un signal de terminaison retardé ; 25
- un second organe tampon à trois états, relié à ladite ligne à retard, pour recevoir ledit signal de terminaison retardé en provenance de ladite ligne à retard et pour sortir ce dernier en réponse audit signal de commande de décalage ; et un inverseur, relié audit premier organe tampon à trois états et audit second organe tampon à trois états, pour inverser ledit signal de commande de décalage au niveau d'un point entre ledit premier organe tampon à trois états et ledit second organe tampon à trois états. 35
- 26. Mémoire selon l'une quelconque des revendications précédentes, comprenant, de plus, un circuit de pilotage de ligne de mots qui reçoit un signal d'horloge, un signal d'activation d'adresse de ligne, et des signaux d'adresse, pour piloter des lignes de mots dans ladite mémoire synchrone dynamique, comprenant :** 40
- un circuit de production de signal d'horloge pour produire un signal d'horloge de mémorisation d'adresse qui devient actif lorsque le signal d'activation d'adresse de ligne et le signal d'horloge sont tous les deux actifs, et qui reste actif jusqu'à ce que ledit signal d'activation d'adresse de ligne devienne inactif ; 50
- un premier circuit transparent de mémorisation, cadencé par ledit signal d'horloge, pour mémoriser ledit signal d'activation d'adresse de ligne et pour produire, à partir de ce dernier, un premier signal interne ; 55
- un second circuit transparent de mémorisation, relié audit circuit de production de signal d'horloge par ledit signal d'horloge de mémorisation d'adresse, pour mémoriser les signaux d'adresse ;
- un circuit de production d'adresse, relié audit second circuit transparent de mémorisation, pour produire une adresse de ligne à partir d'une sortie dudit second circuit transparent de mémorisation ;
- un circuit de décodage de ligne de mots, relié audit circuit de production d'adresse, pour décoder ladite adresse de ligne, sélectionnant ainsi une ligne de mots particulière, et pour produire un second signal interne qui devient actif lorsque ladite ligne de mots a été sélectionnée ; et
- des moyens de sélection par porte et de pilotage, reliés audit premier circuit transparent de mémorisation et audit circuit de décodage de ligne de mots, pour recevoir un signal de commande, pour sélectionner par porte ledit premier signal interne selon ledit second signal interne et ledit signal de commande pour produire un signal de pilotage, et pour piloter la ligne de mots sélectionnée par ledit signal de pilotage.
- 27. Circuit selon la revendication 26, dans lequel ledit signal d'horloge de mémorisation d'adresse est utilisé en tant que dit signal de commande.** 30
- 28. Circuit selon la revendication 26, dans lequel lesdits moyens de sélection par porte et de pilotage comprennent :**
- une porte ET à trois entrées ayant ledit premier signal d'entrée, ledit second signal d'entrée, et ledit signal de commande en tant qu'entrées ; et
- un dispositif de pilotage de ligne de mots relié à ladite porte ET à trois entrées, pour produire ledit signal de pilotage à partir de la sortie de ladite porte ET à trois entrées.

FIG. 1

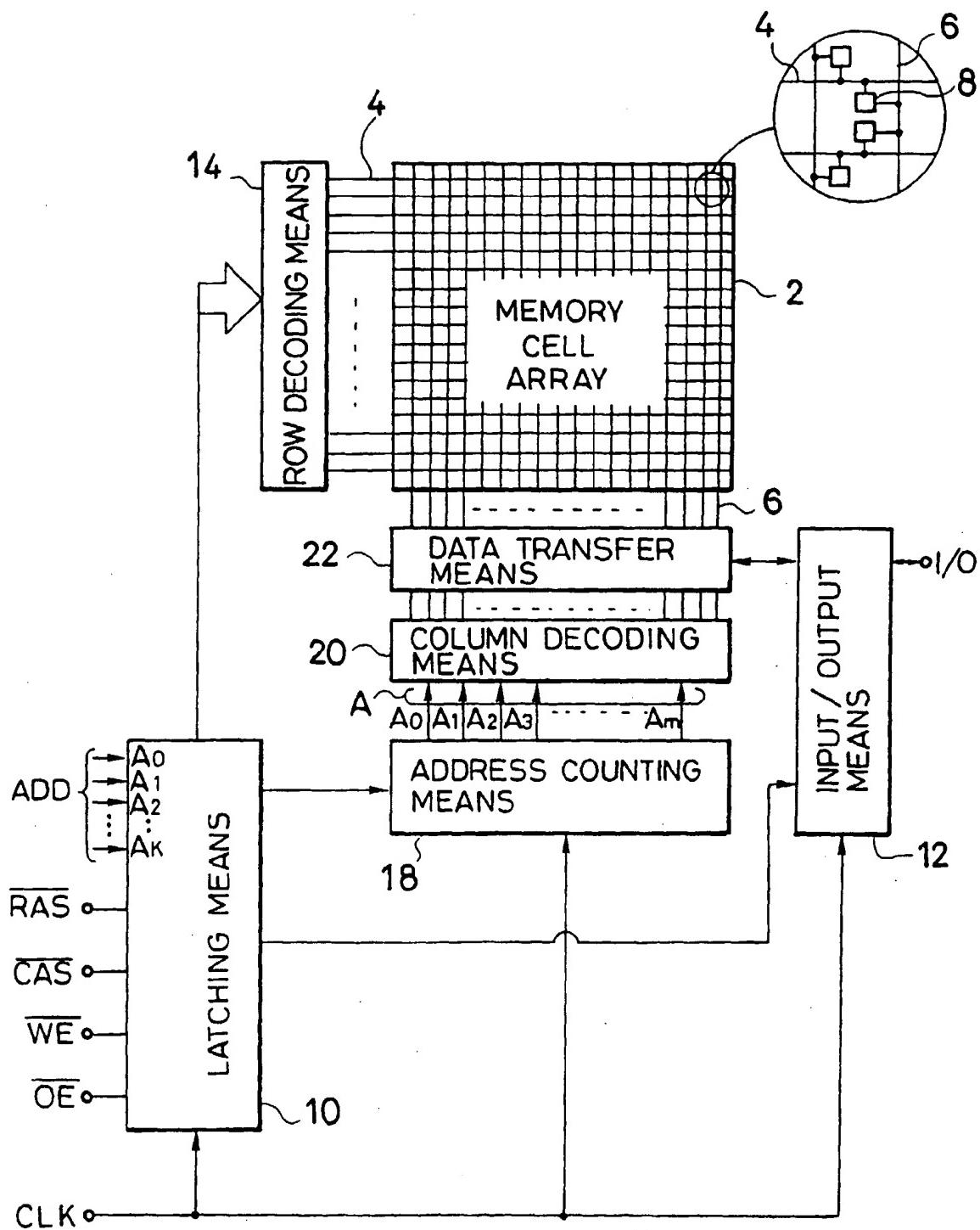


FIG. 2

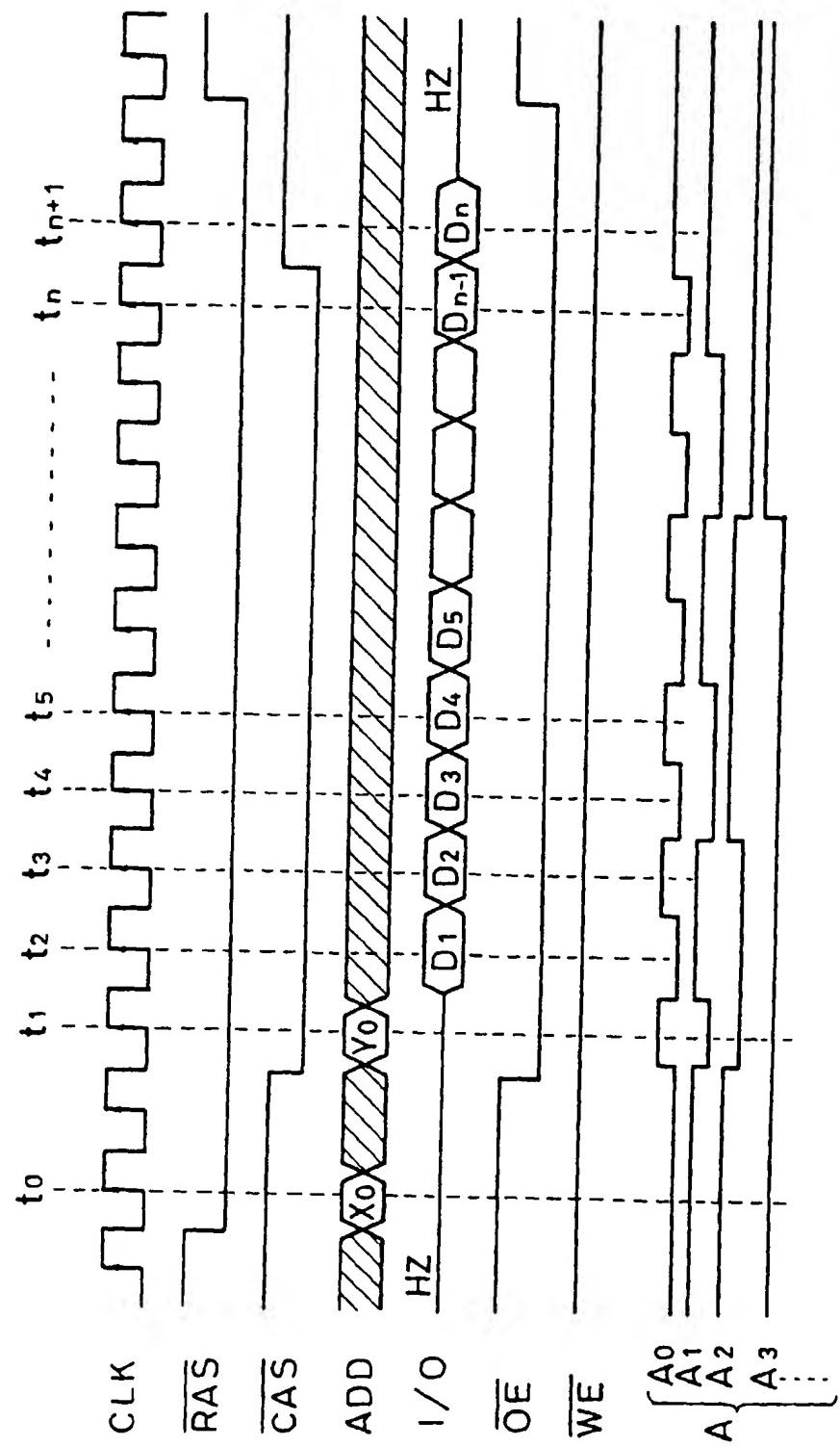


FIG. 3

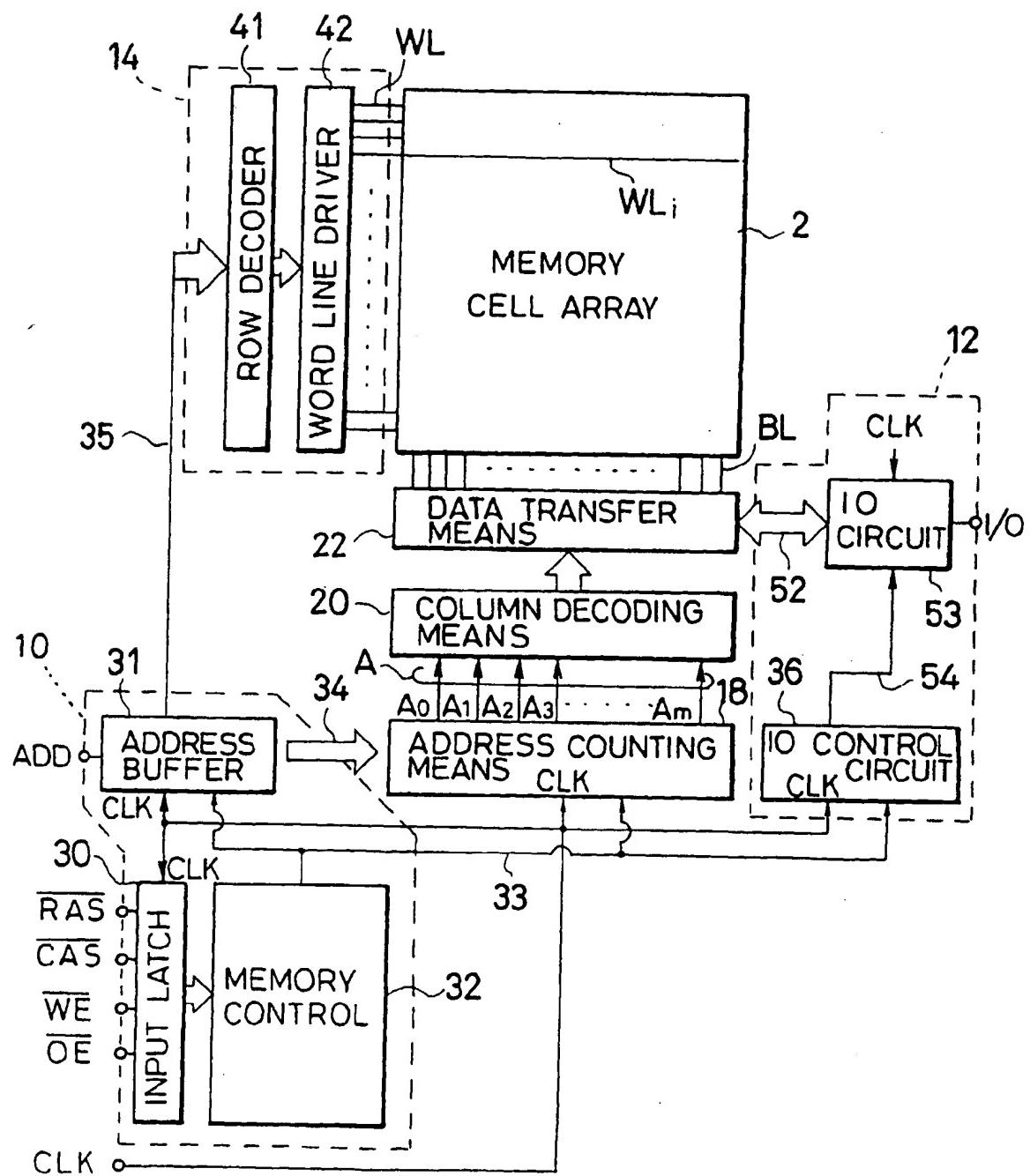


FIG. 4

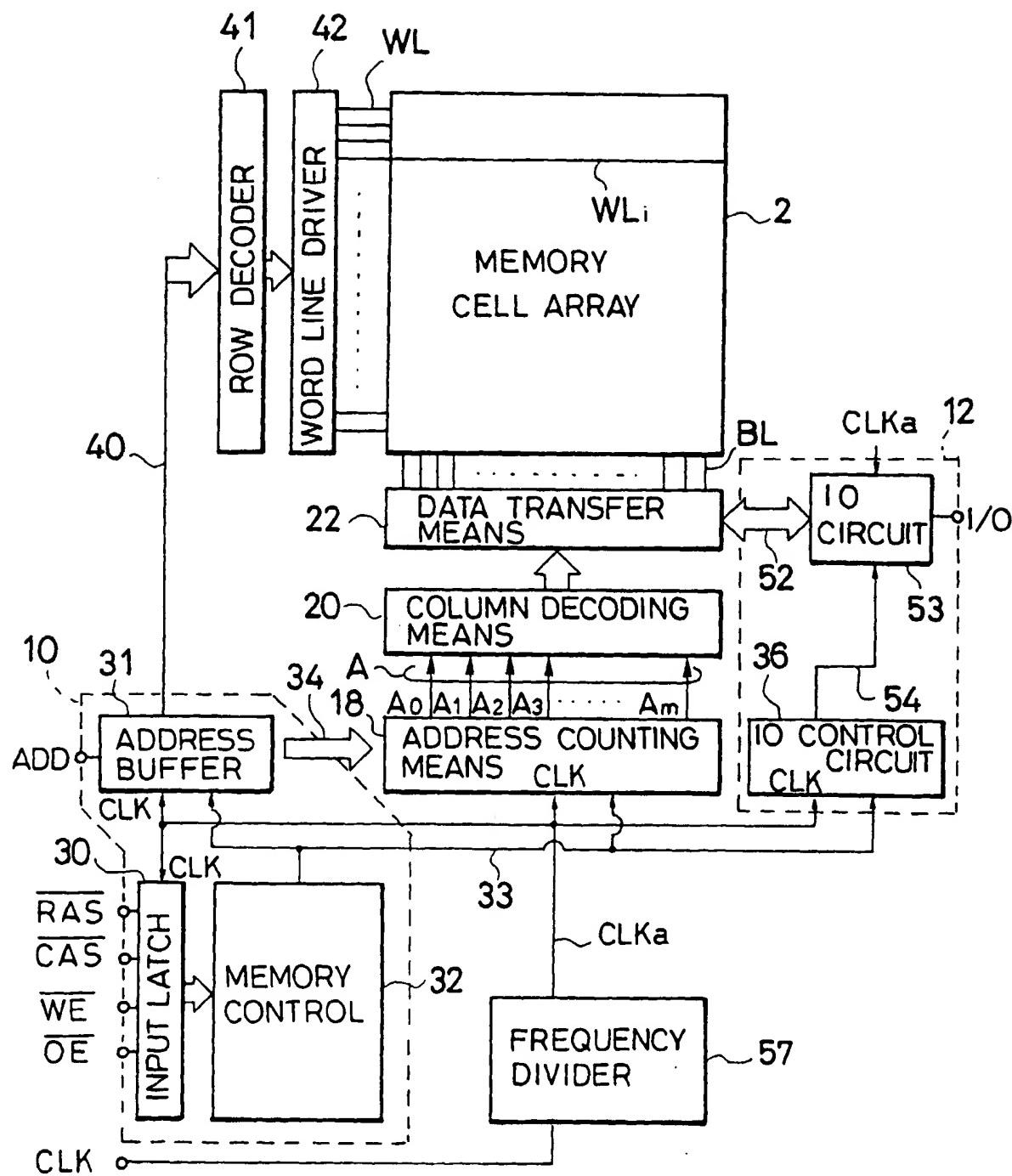


FIG. 5

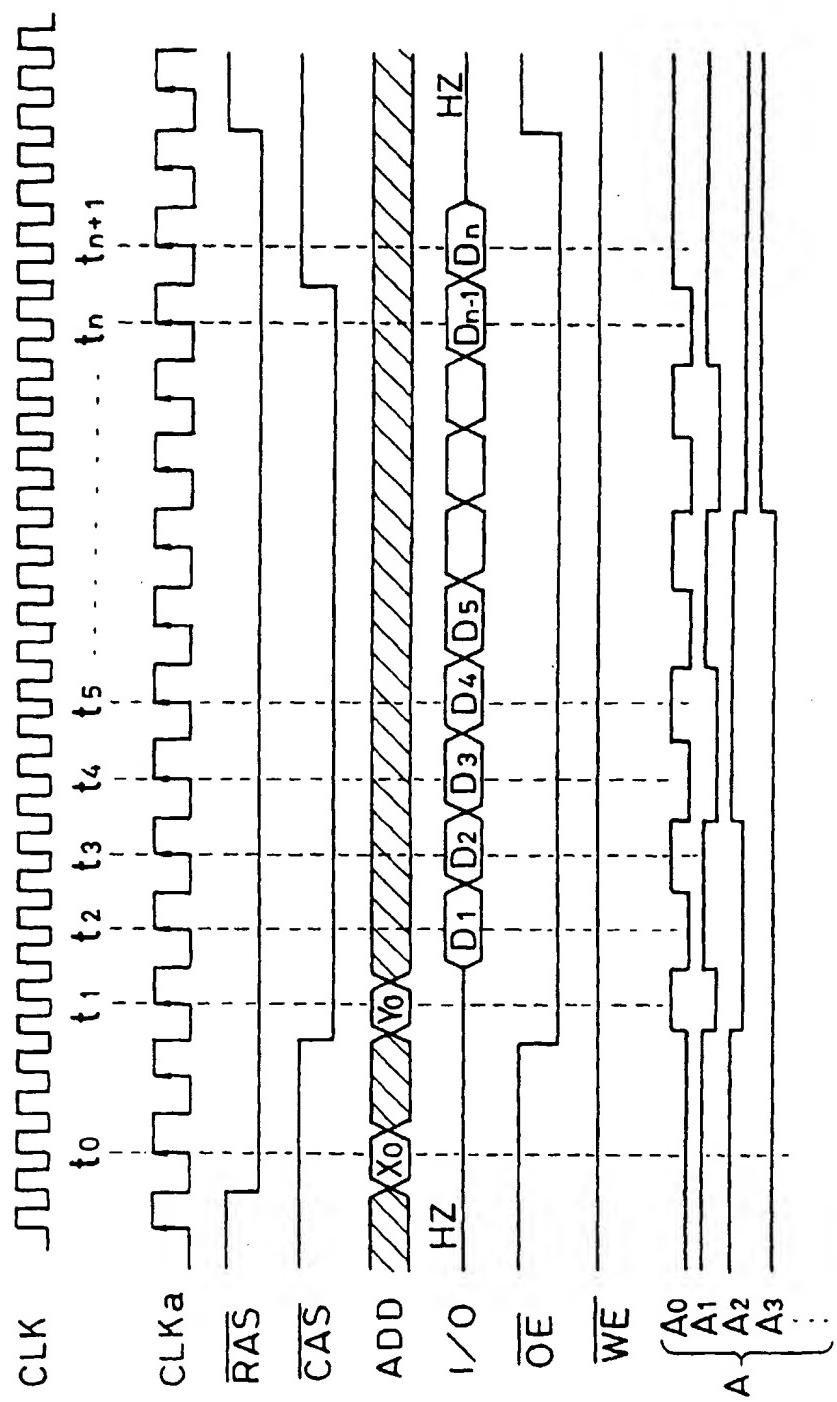


FIG. 6

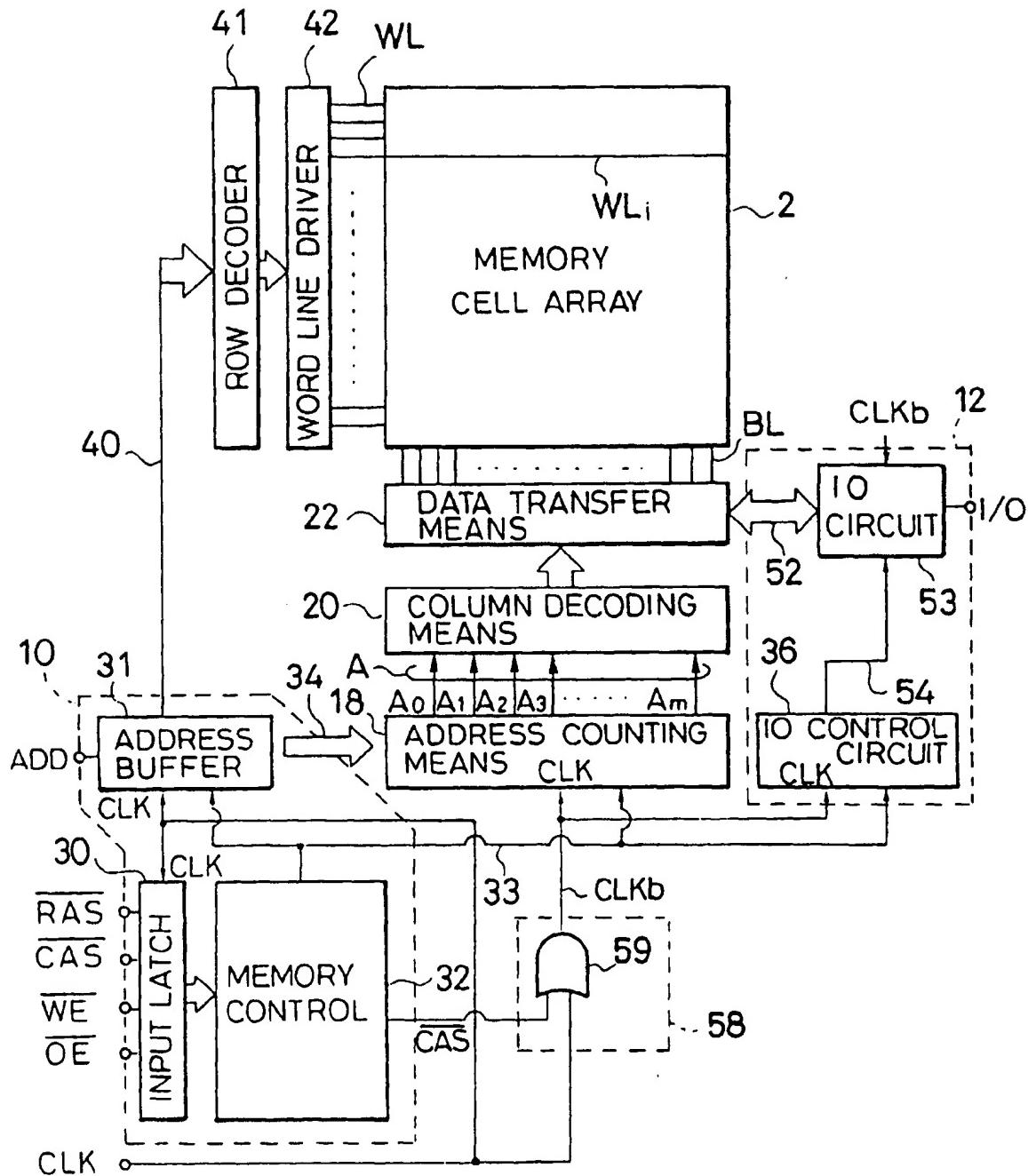


FIG. 7

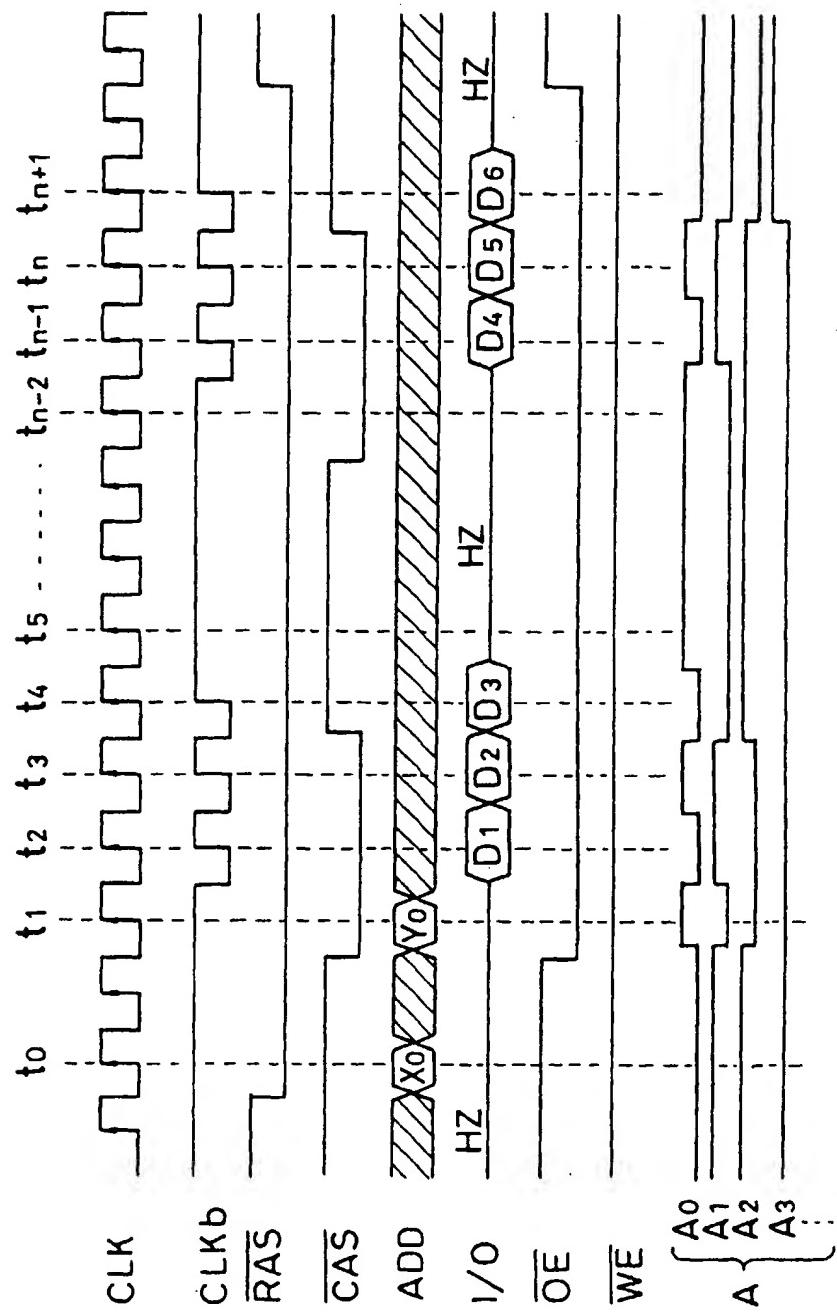


FIG. 8

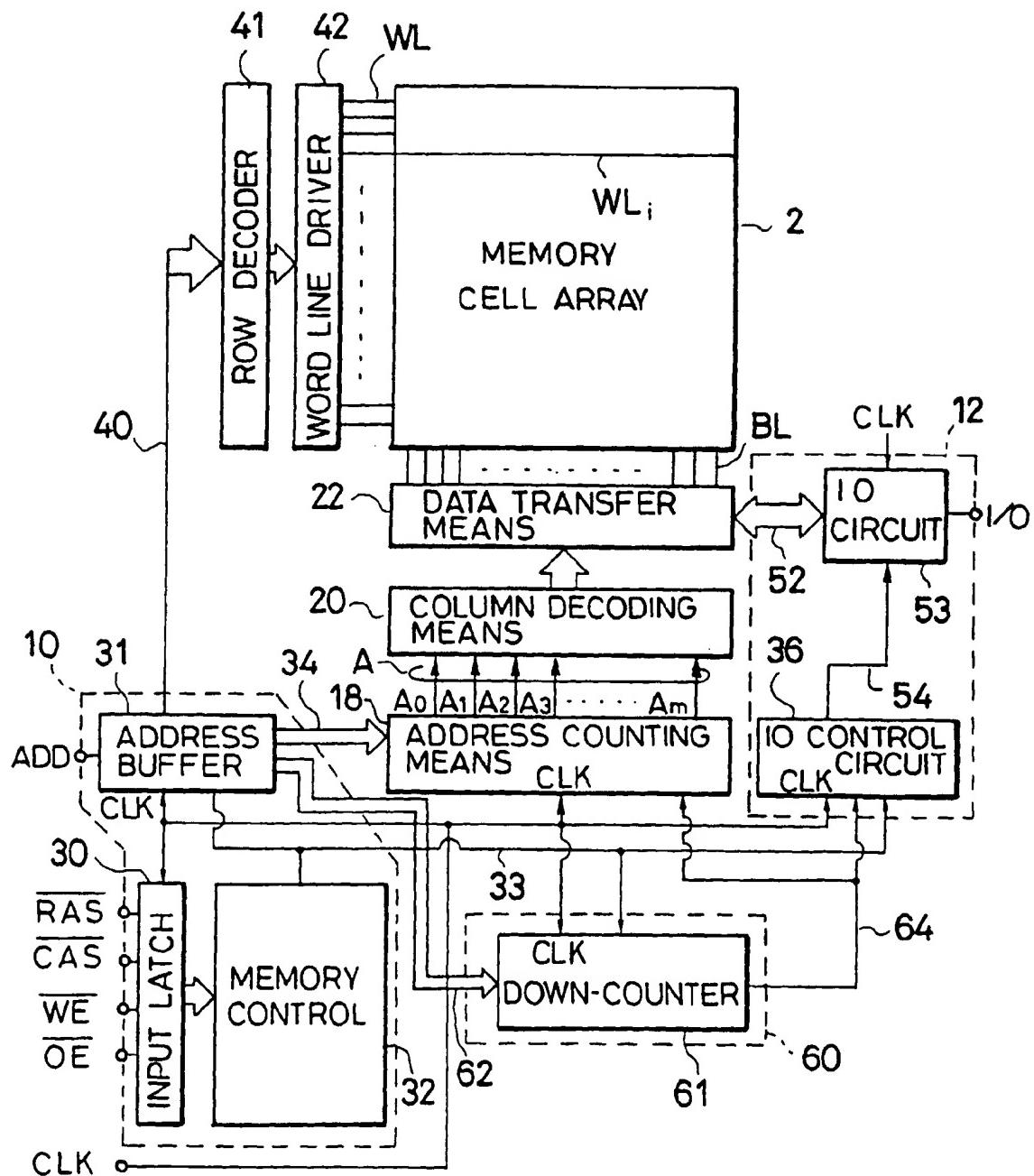


FIG. 9A

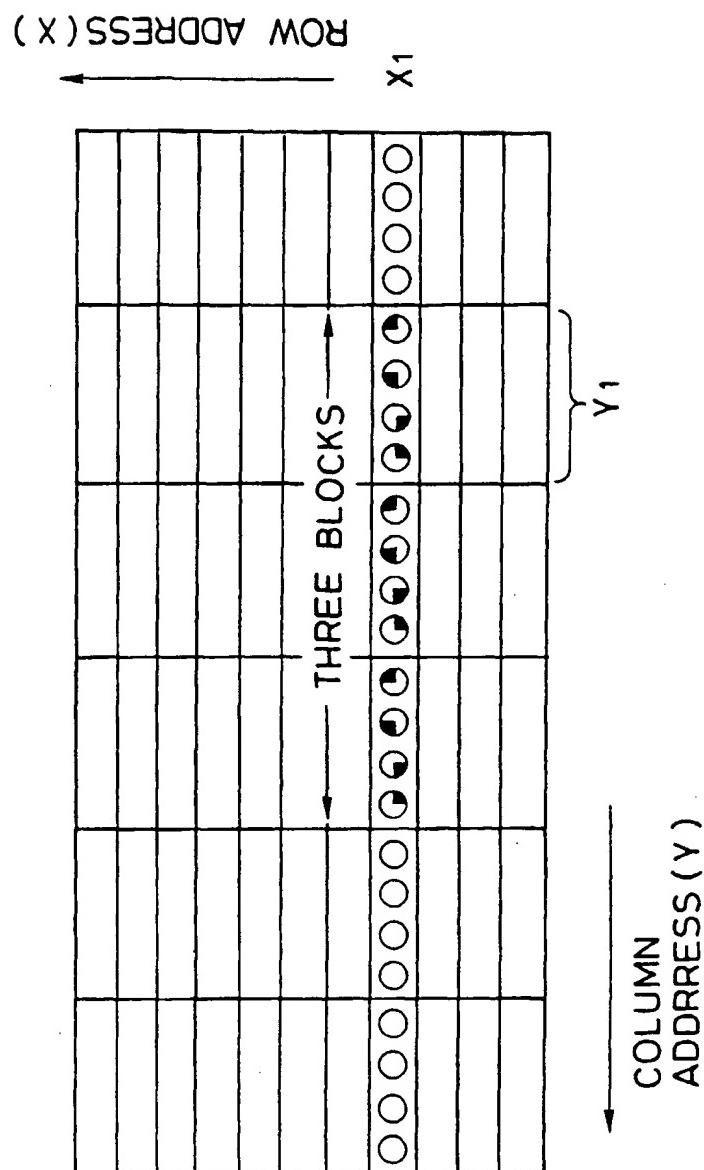


FIG. 9B

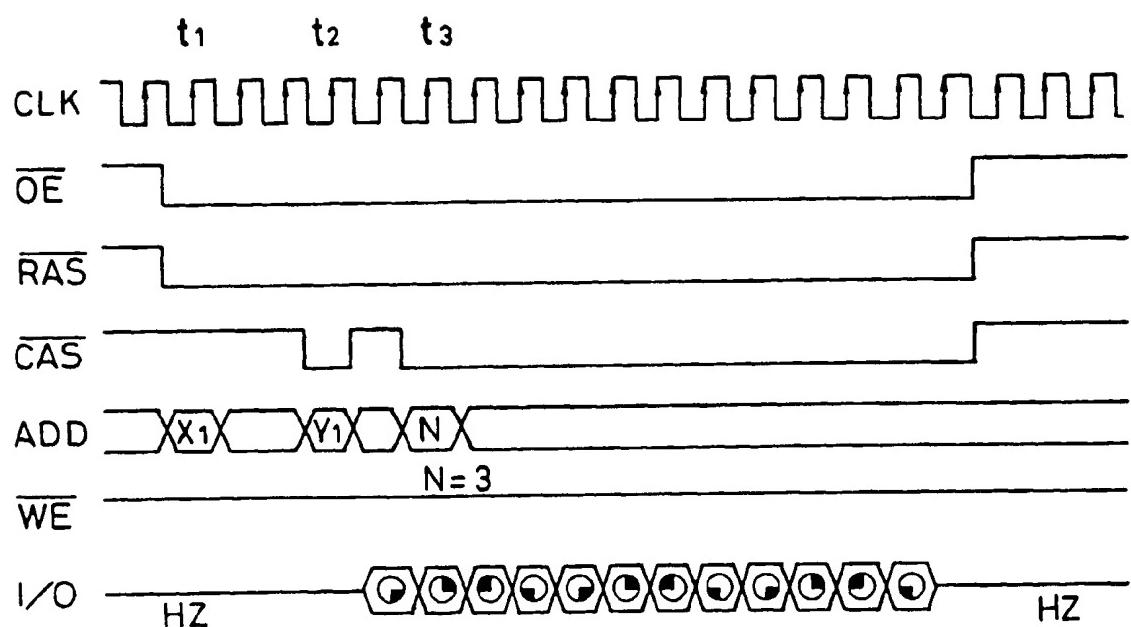


FIG. 10

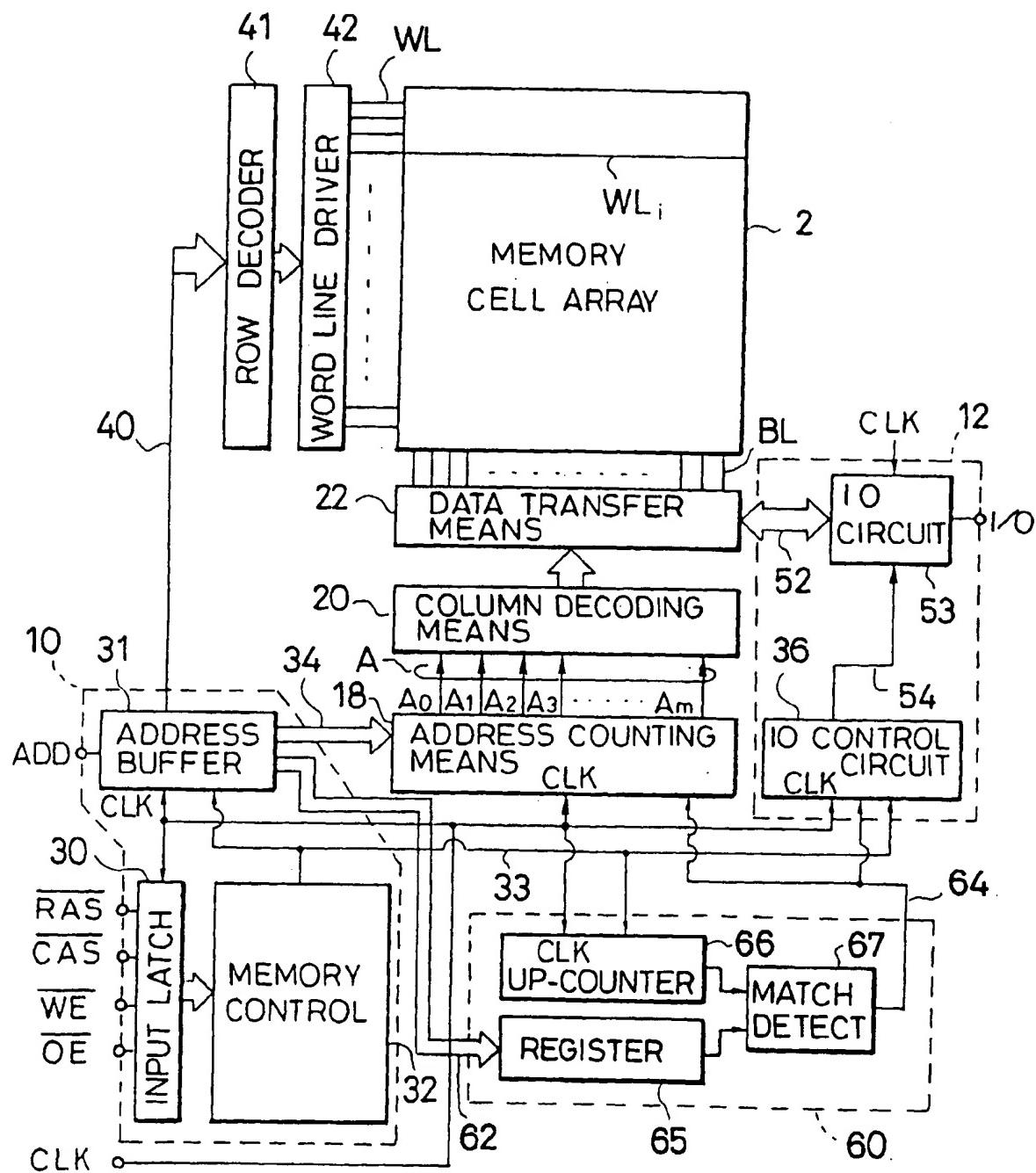


FIG. 11A

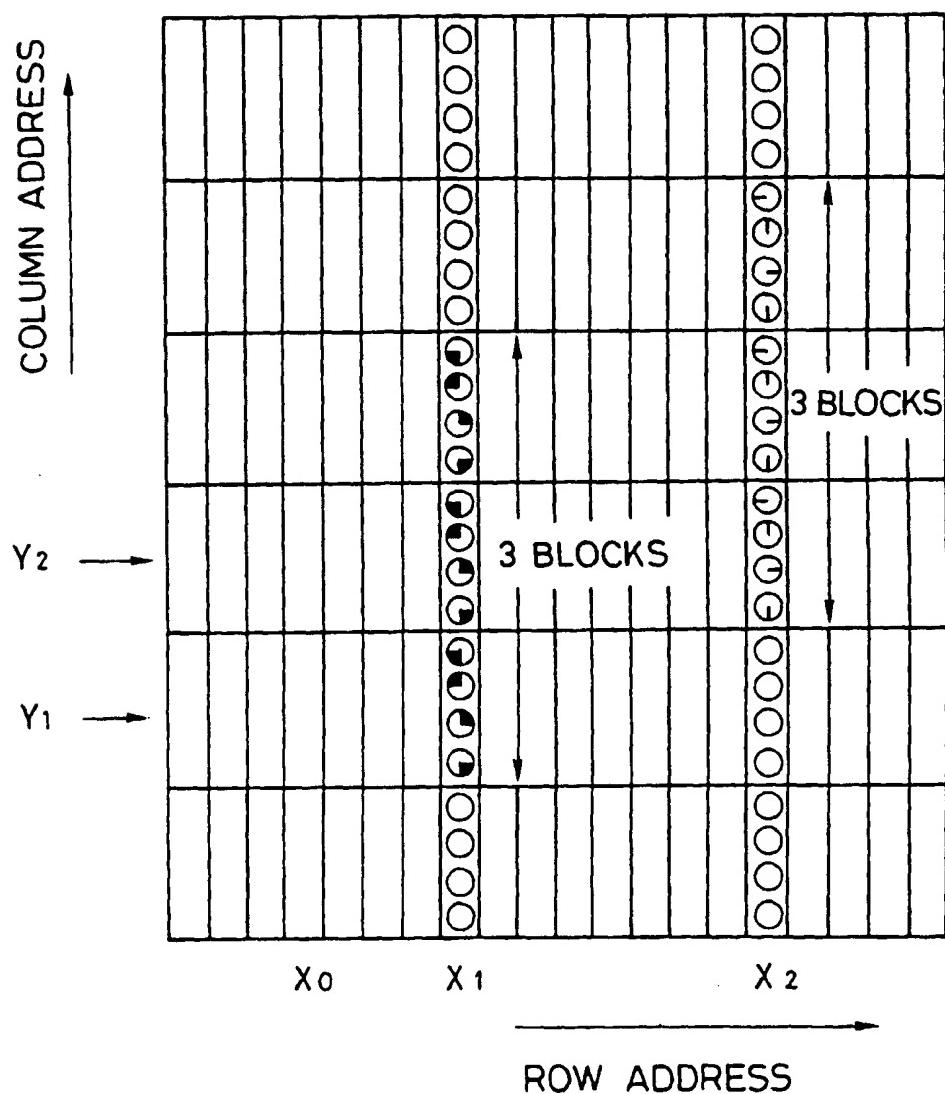


FIG. 1 1B

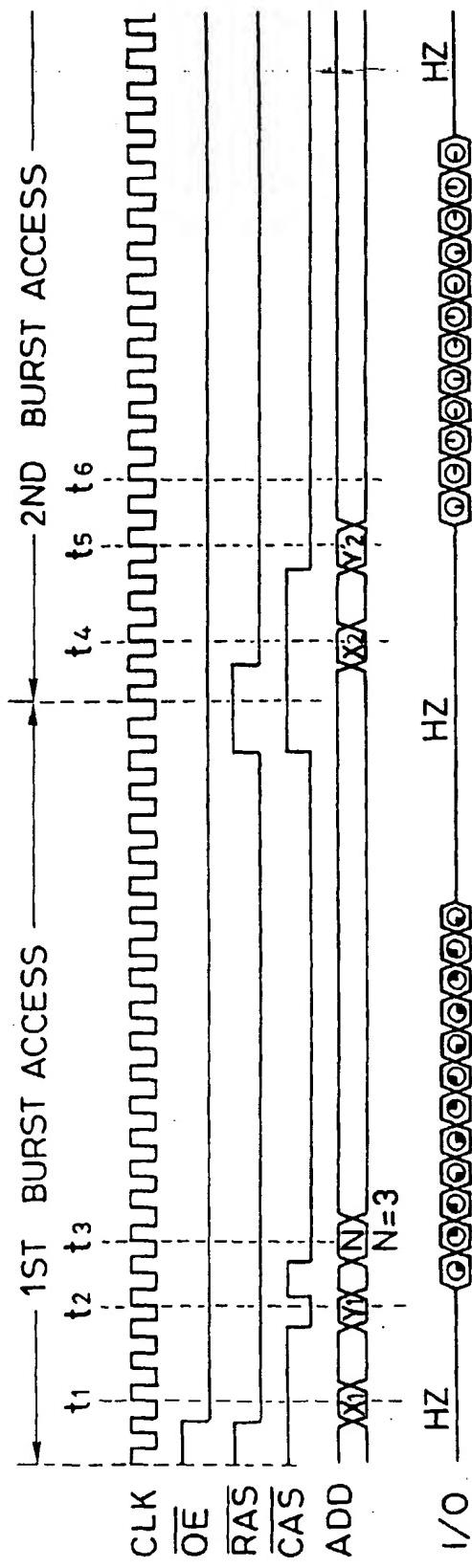


FIG. 12

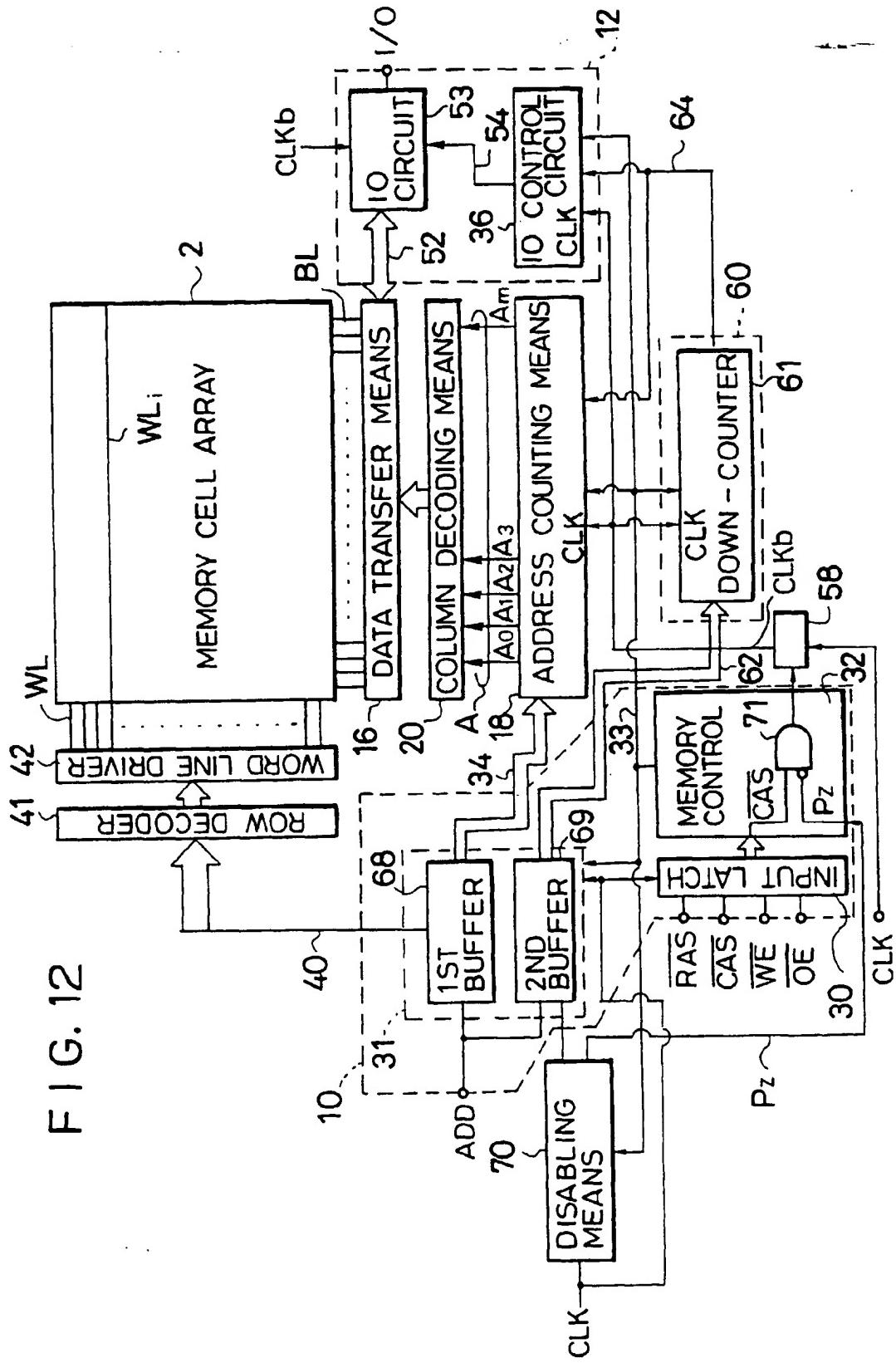


FIG. 13A

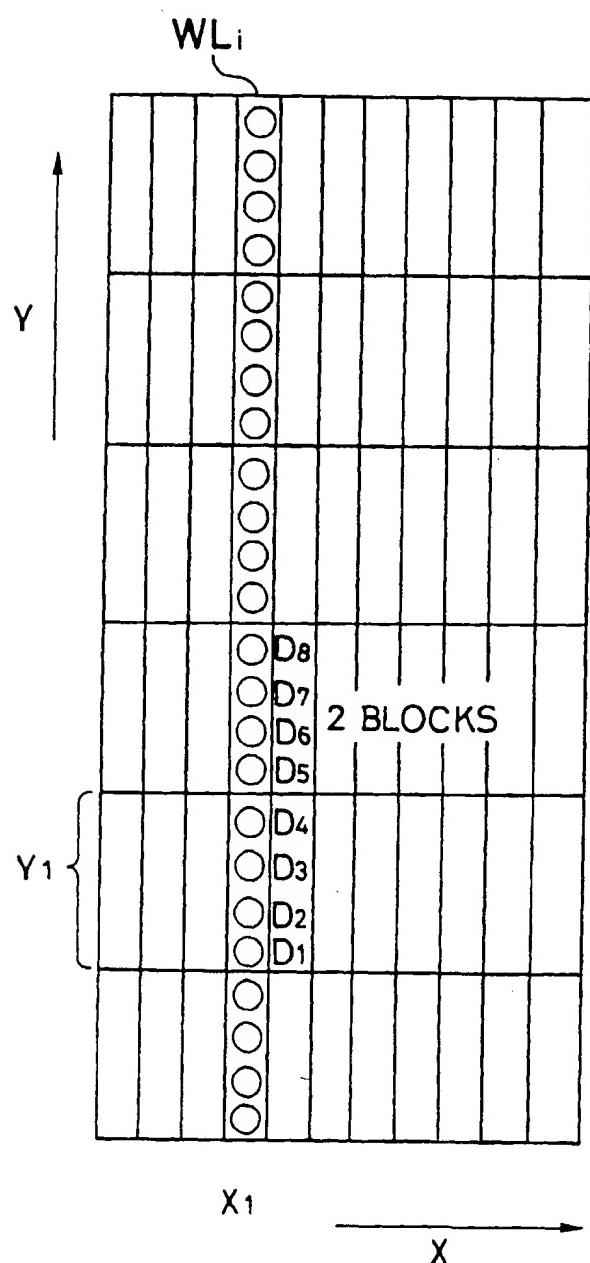


FIG. 13B

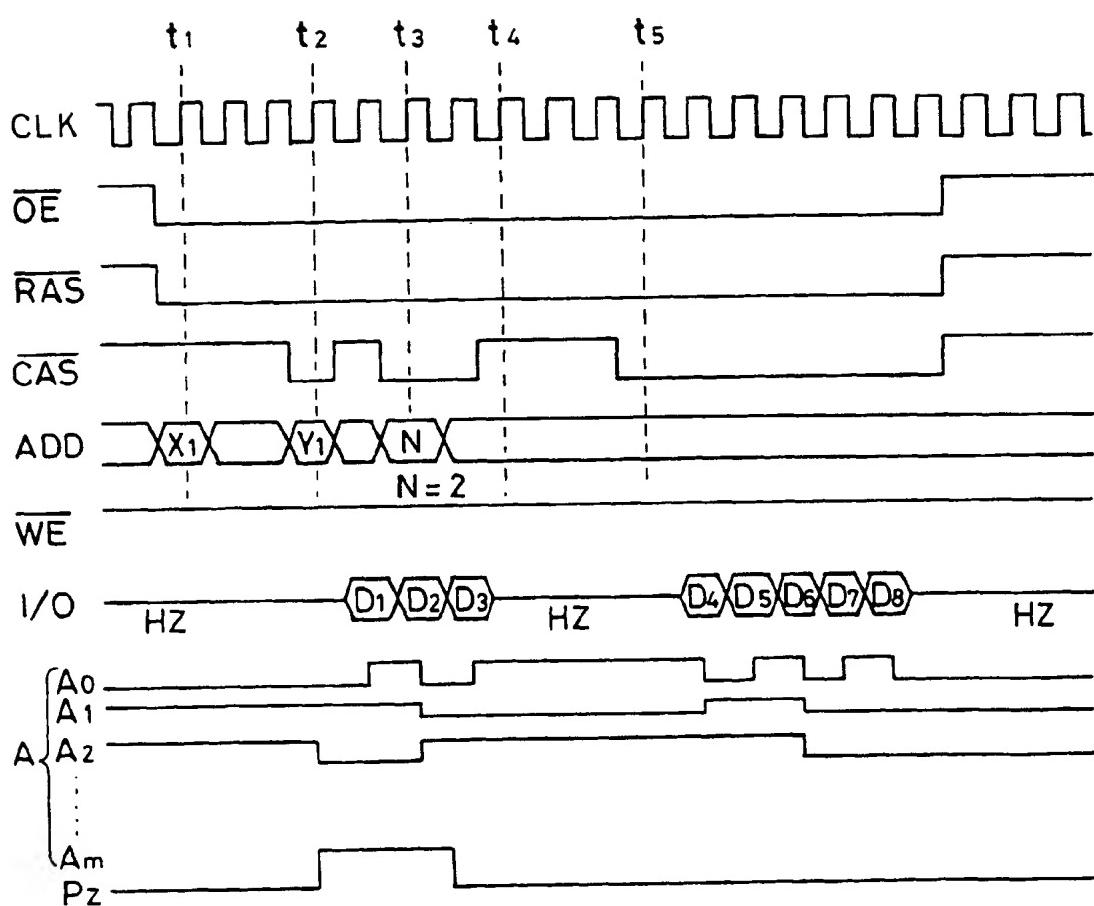


FIG. 14

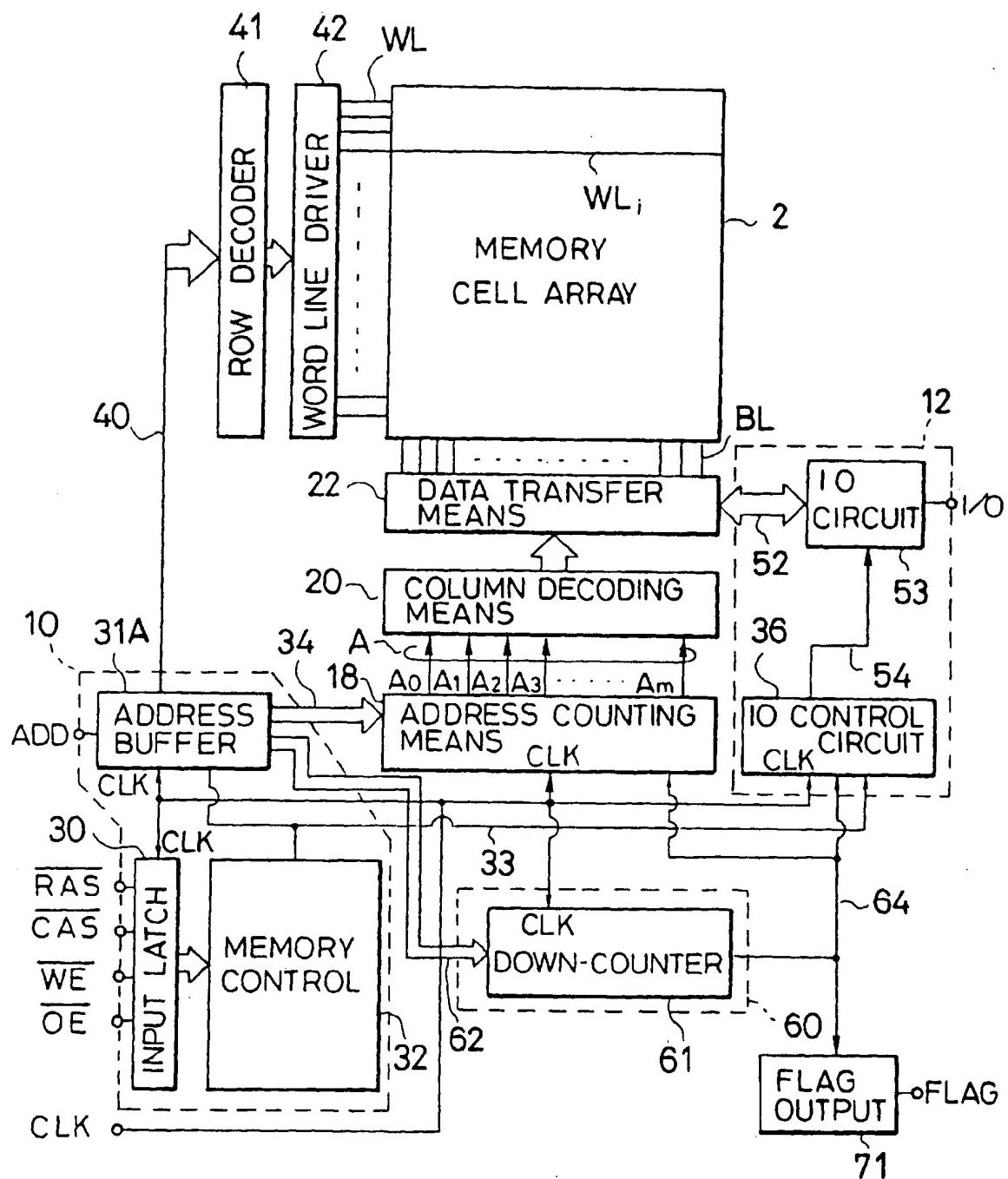


FIG. 15

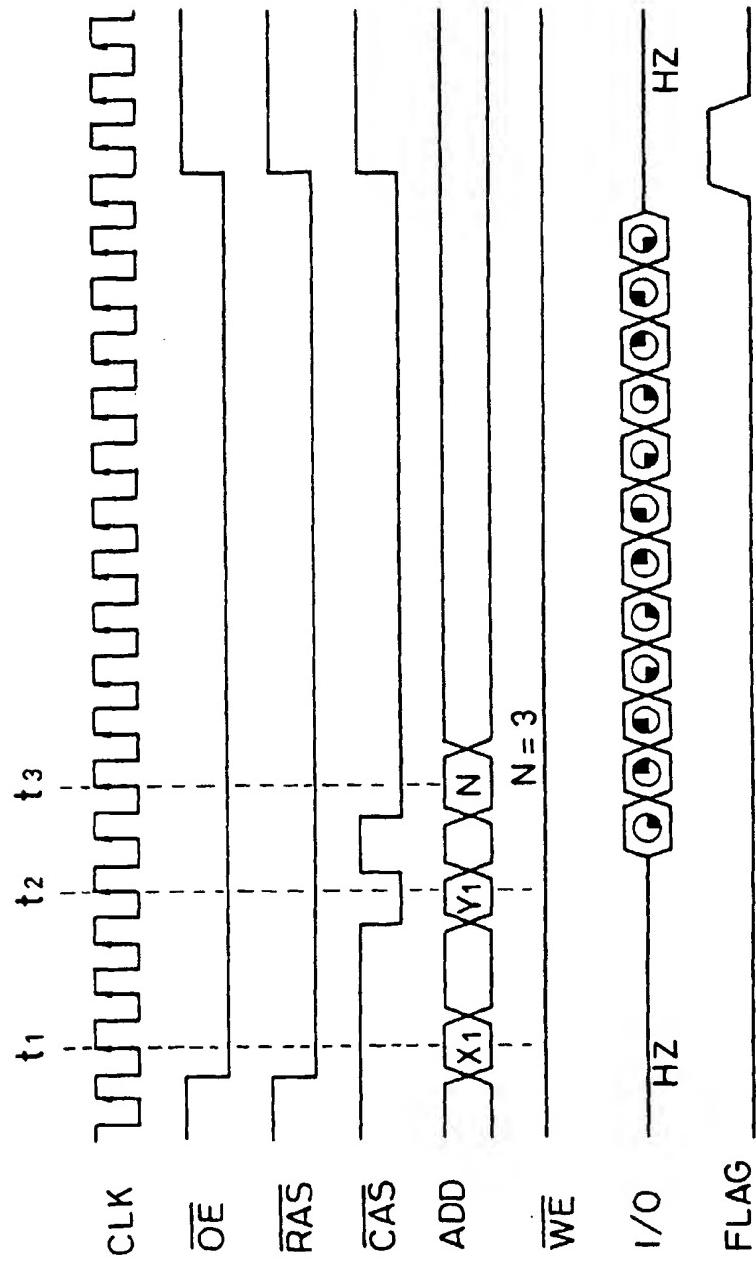


FIG. 16

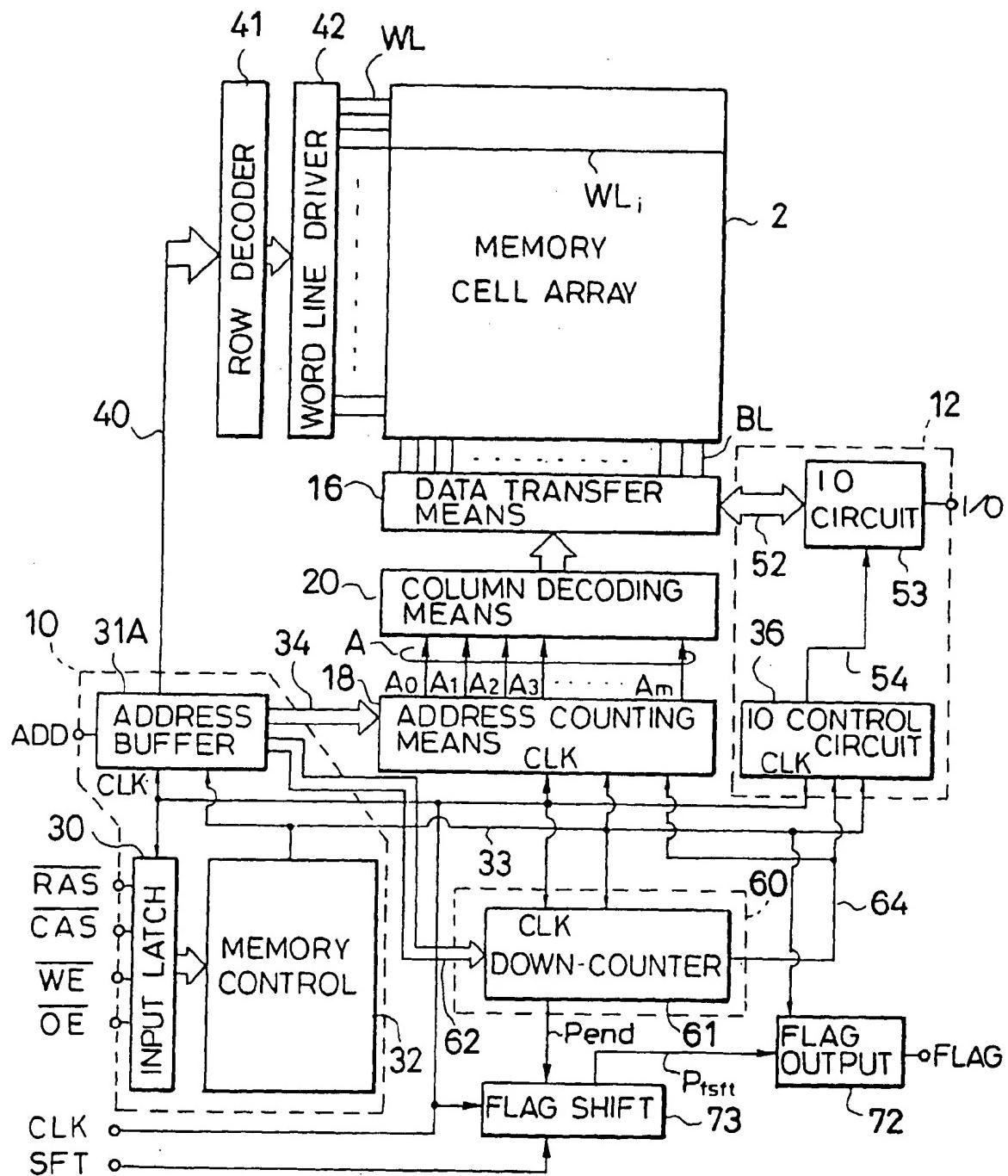


FIG. 17

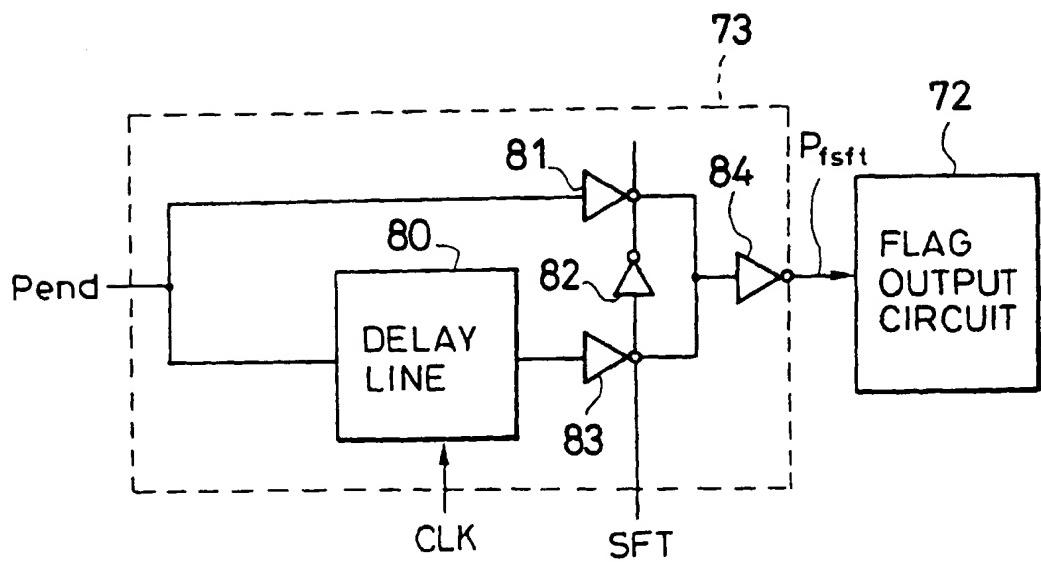


FIG. 18

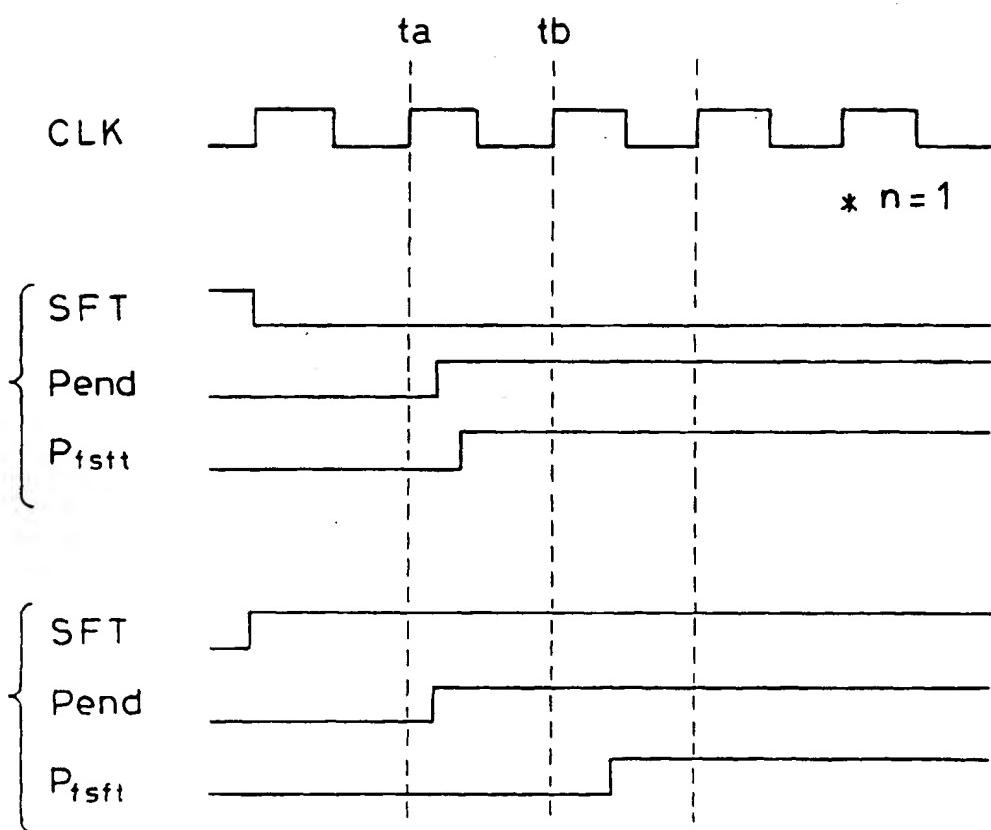


FIG. 19

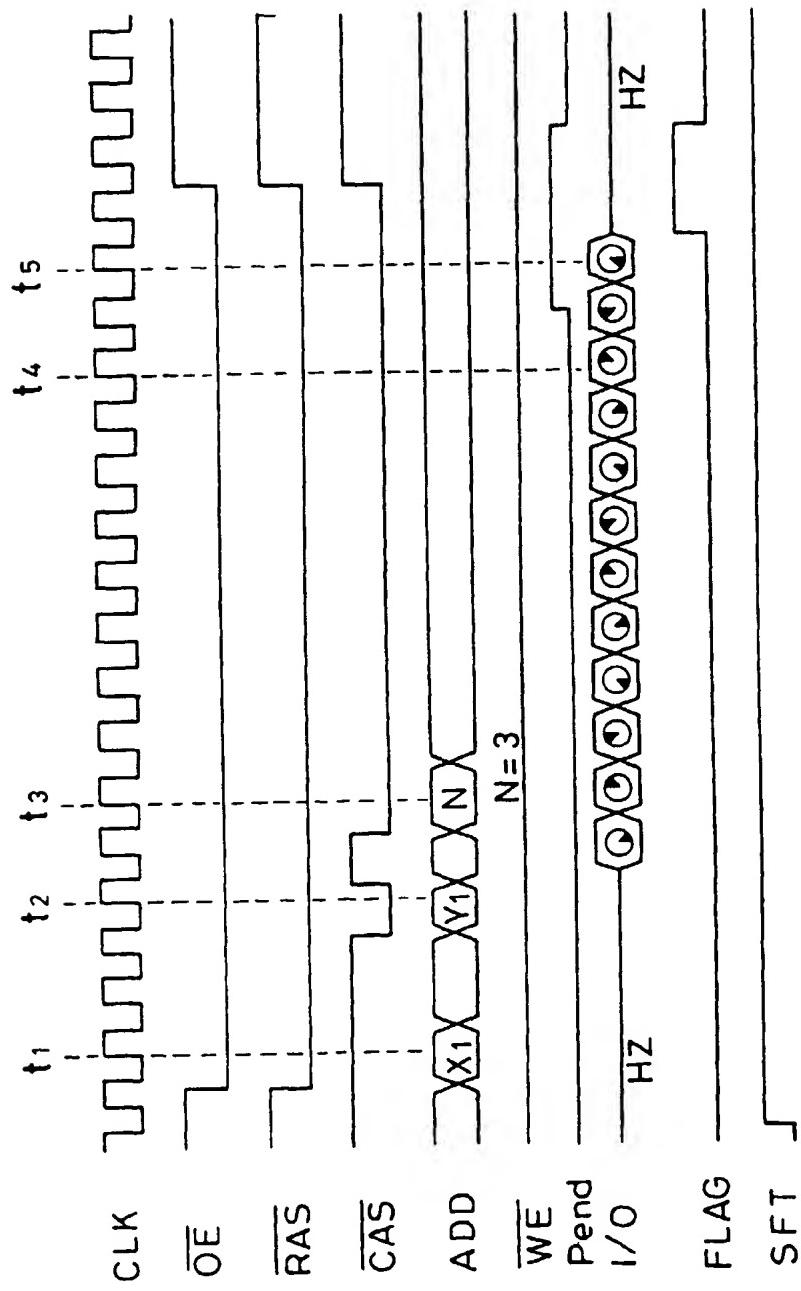


FIG. 20

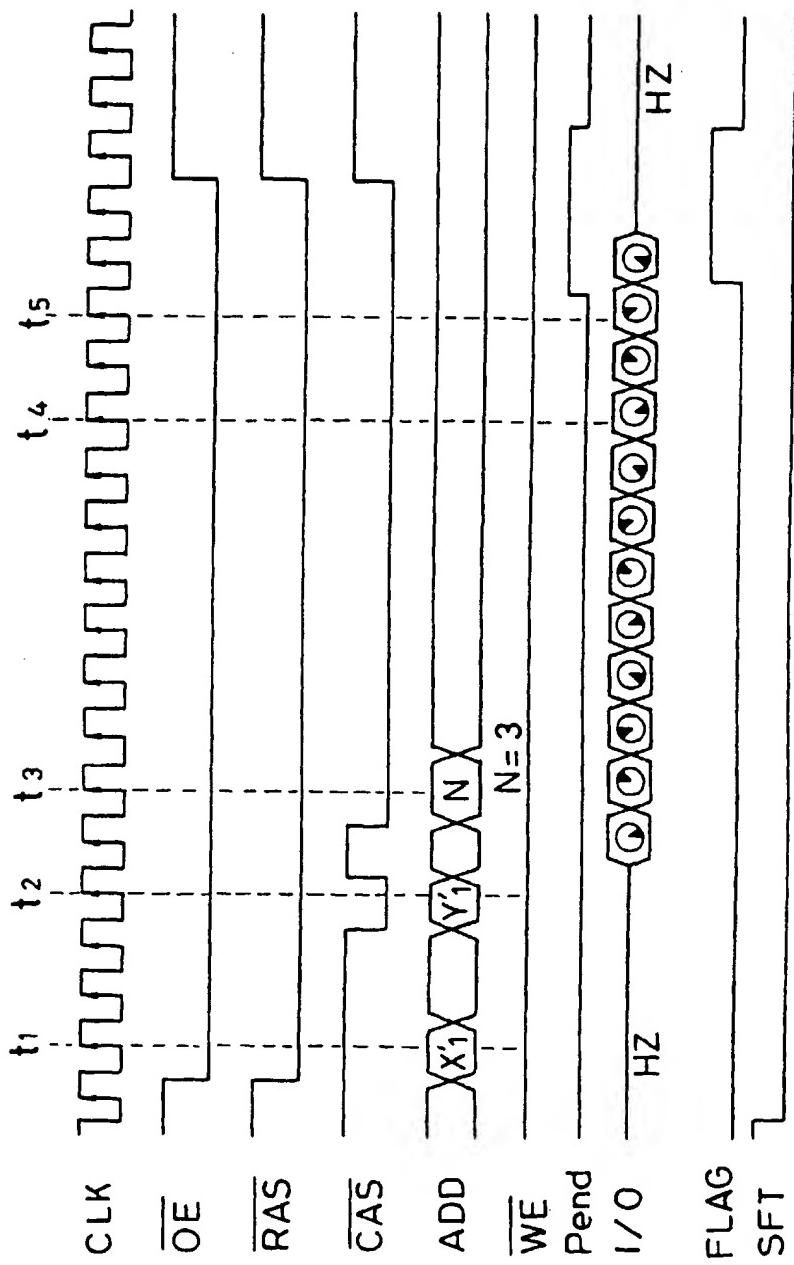


FIG. 21

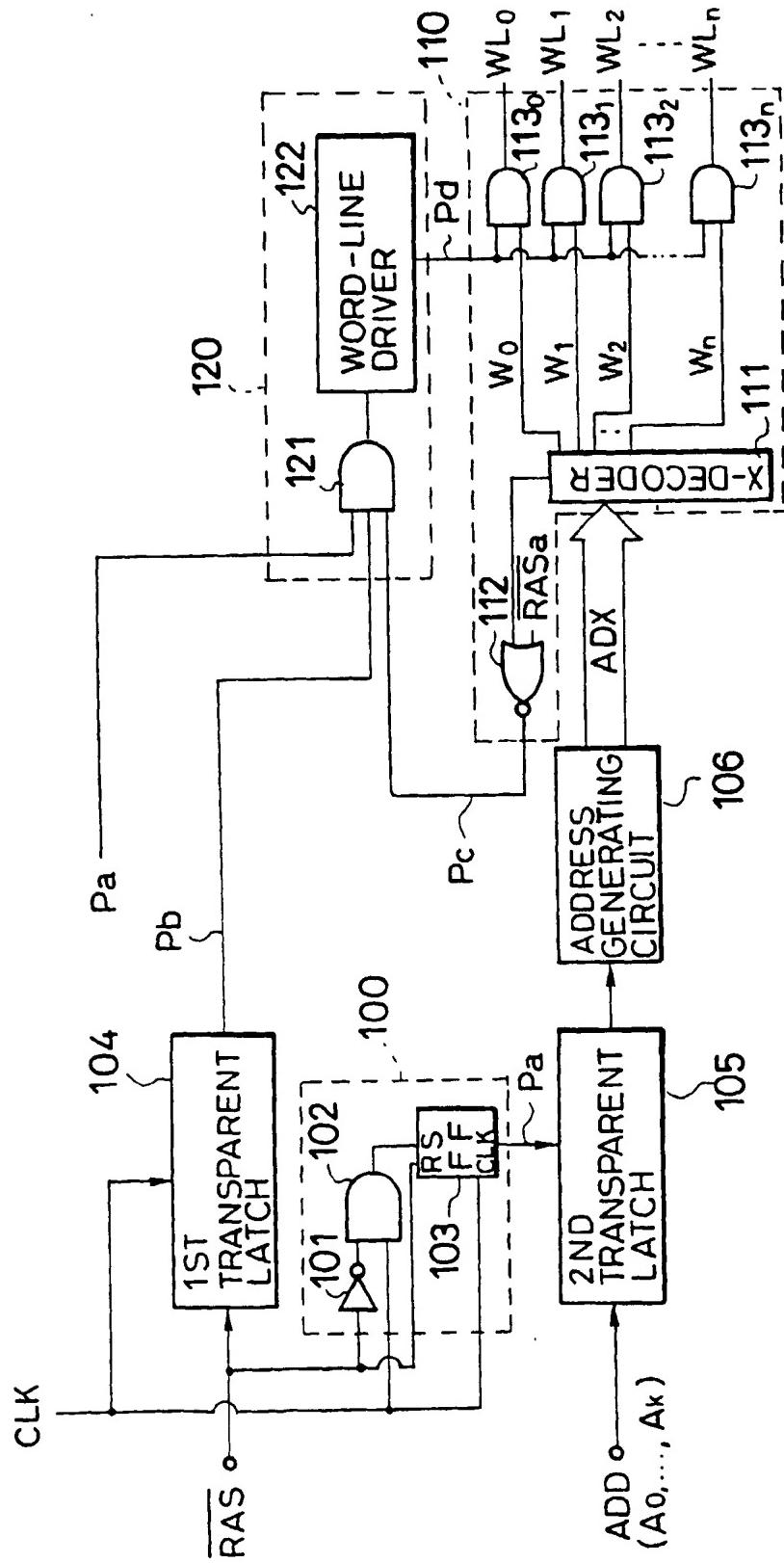
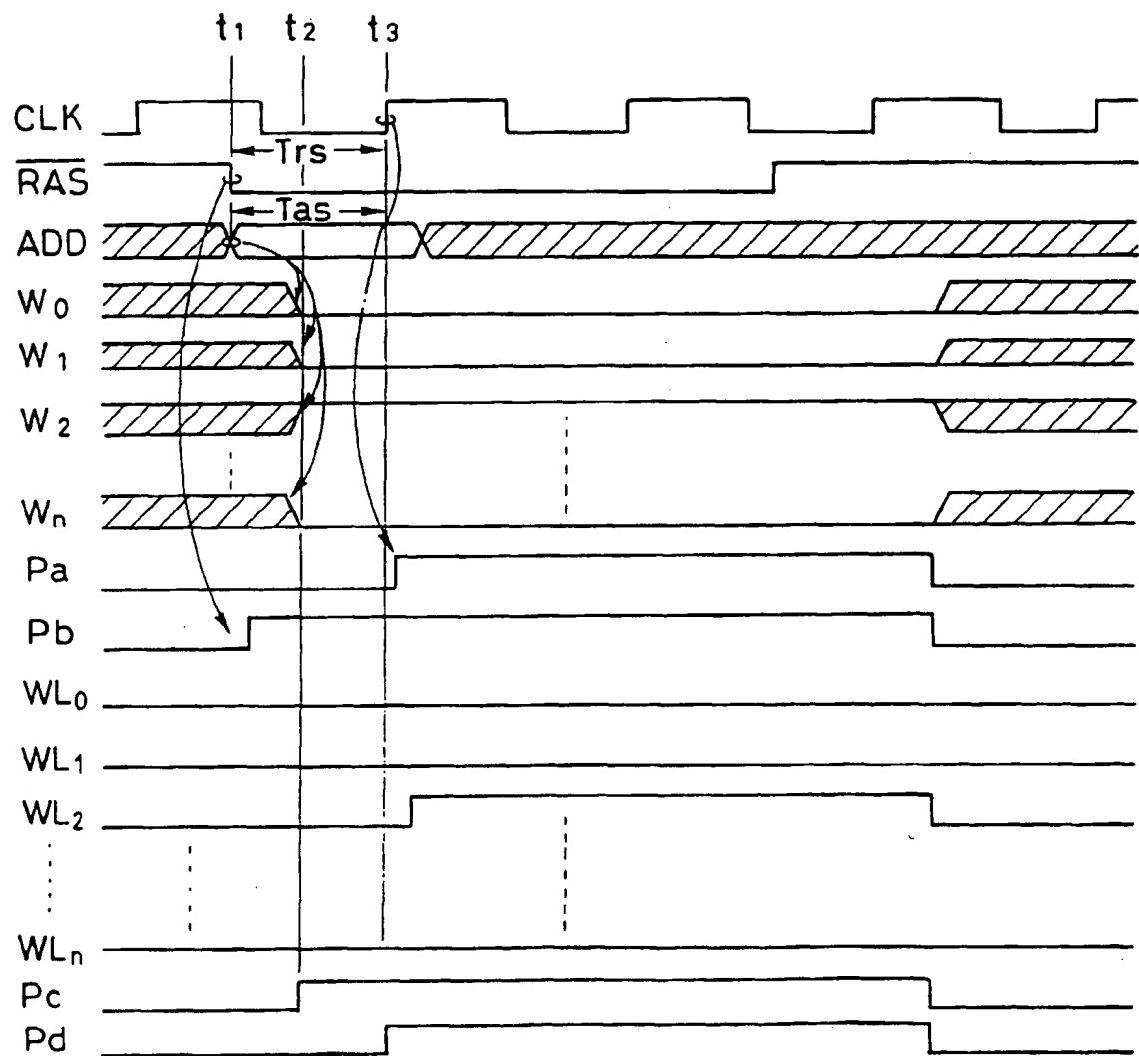


FIG. 22



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